Met Office initial assessment of AIRS focus day BUFR radiances

Roger Saunders
Met Office (UK)

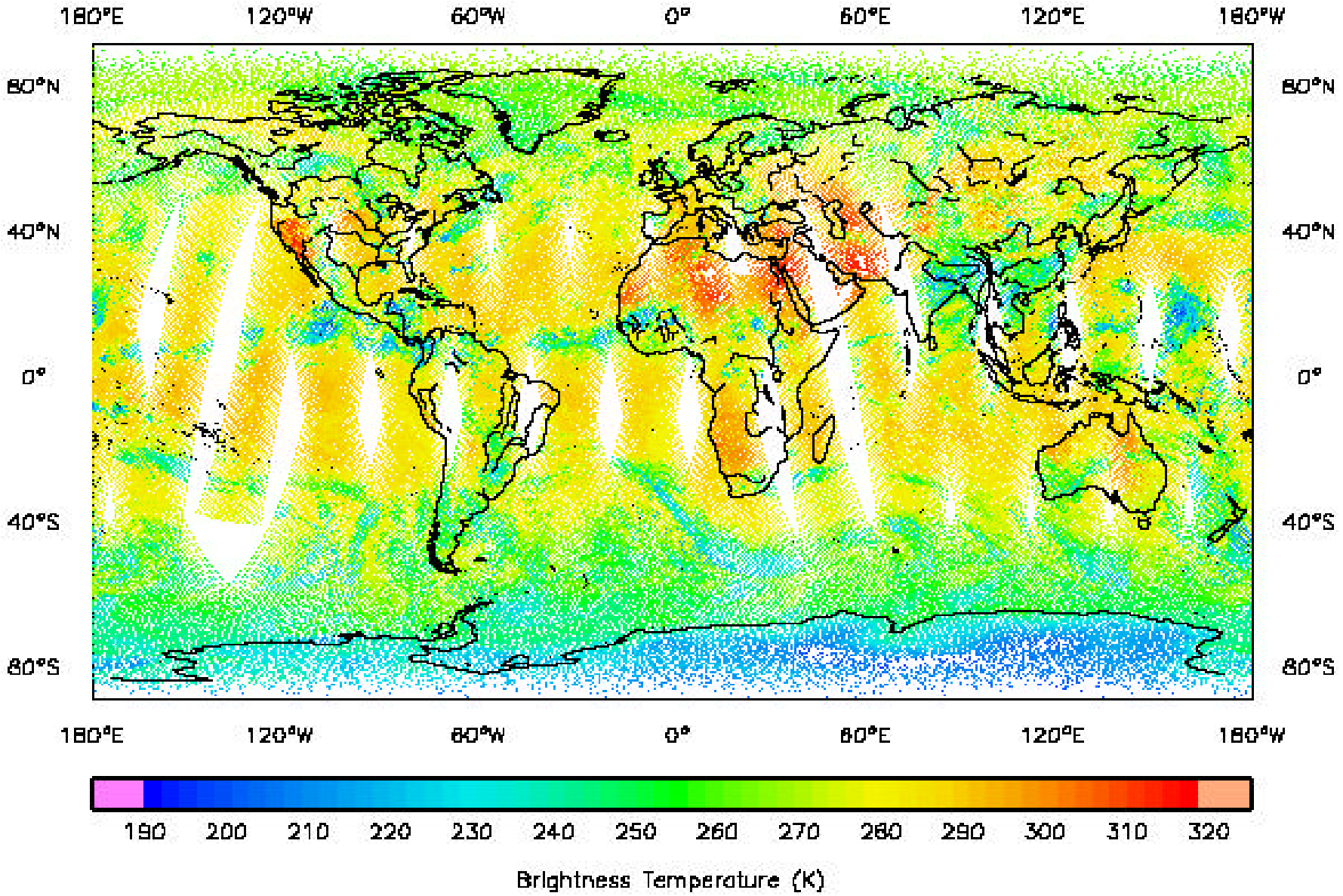
- Input Data and Model description
- Cloud detection
- Results for focus day (20 July 02)
- Future plans at Met Office

Acknowledgements

A. Collard, J. Cameron, Y. Takeuchi, P. Rayer, M. Matricardi & J. Eyre

AIRS data studied

- BUFR format from NESDIS
- 20 July 2002 0 - 21Z
- 324 AIRS +15 AMSU-A channels
- 1 AIRS for alternate AMSU-A FOVS
- (+ HIRS/AMSU-A from NOAA-16)


Observed BT for Channel 870 947.965 cm−1 (ival = 138)
180°E
120°W
60°W
0°
60°E
120°E
180°W
80°N
40°N
0°
40°S
80°S
190
200
210
220
230
240
250
260
270
280
290
300
310
320
Brightness Temperature (K)

Met Office NWP Models

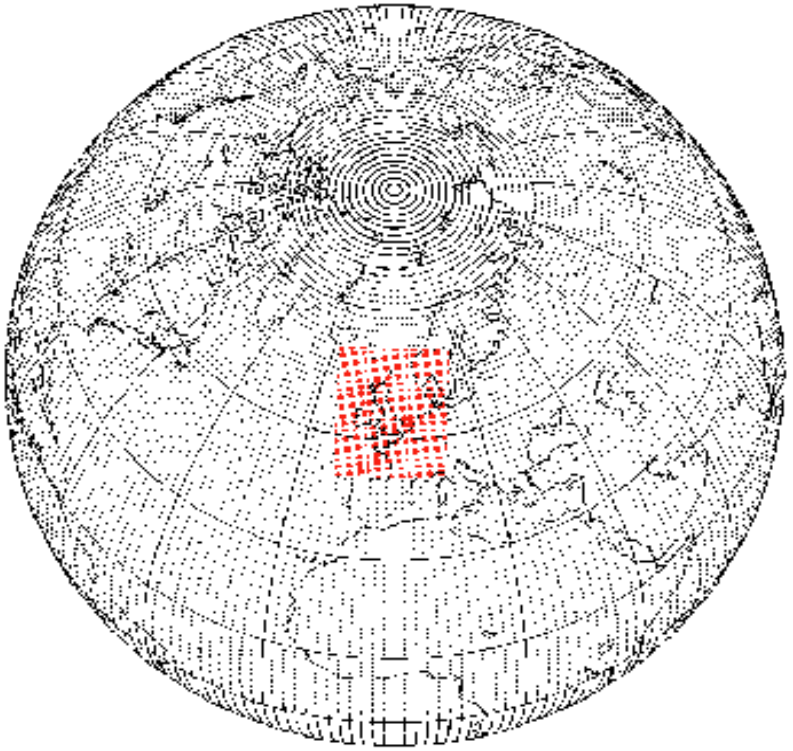


Figure 2: The grids used by the global and UK Mesoscale forecast systems.

	Horizontal Resolution	Horizontal Grid EW x NS	Vertical Levels
Global Forecast	0.83° x 0.56°	432 x 325	30
UK Mesoscale	12km	146 x 182	38
HADAM4	2.50° x 3.75°	96 x 73	38

Table 1: Resolutions used by main UM atmospheric configurations.

Model formulation:

Exact equations of motion in 3D, non-hydrostatic effects included, semi-Langrangian scheme, hybrid-eta in height.

Data Assimilation:

3DVar, FGAT, 6 hourly cycle
3hr cut-off with update runs for next cycle

Provides model background from 6 hour forecast

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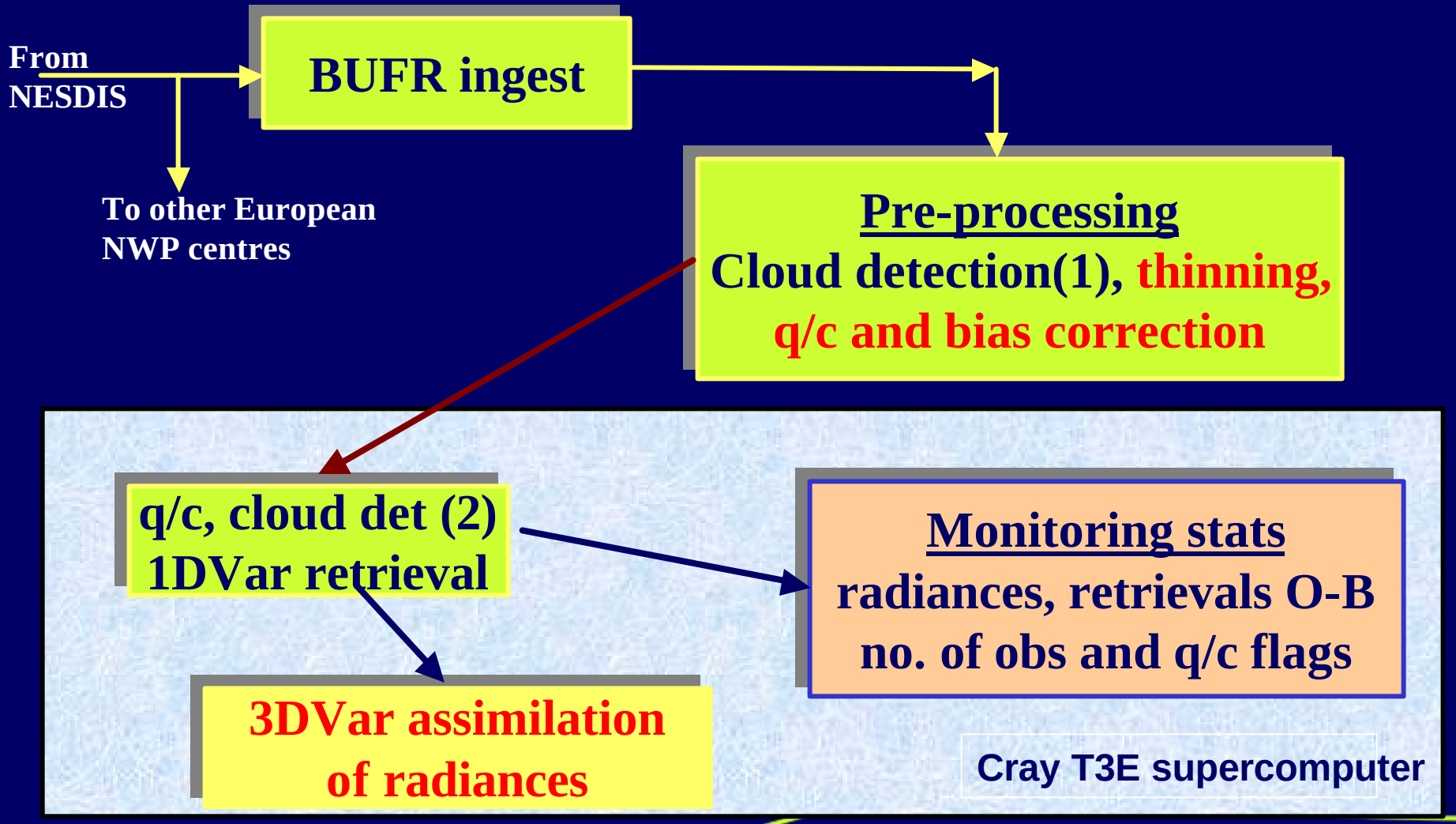
AIRS processing



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Radiative transfer model used

- RTTOV-7 developed by NWP SAF
  - **ISRF from Strow (2000)** **Needs updating now!**
  - **Line database: HITRAN-96**
  - **LbL model GENLN2 at 0.001cm^{-1}**
  - **Water vapour continuum: CKD2.1**
  - **43L fixed pressure level parametrisation**
  - **T, q, surface from NWP model O_3 inferred from temp at 70hPa**
  - **Masuda for sea surface emissivity, 0.98 for land**
  - **Jacobians also computed**

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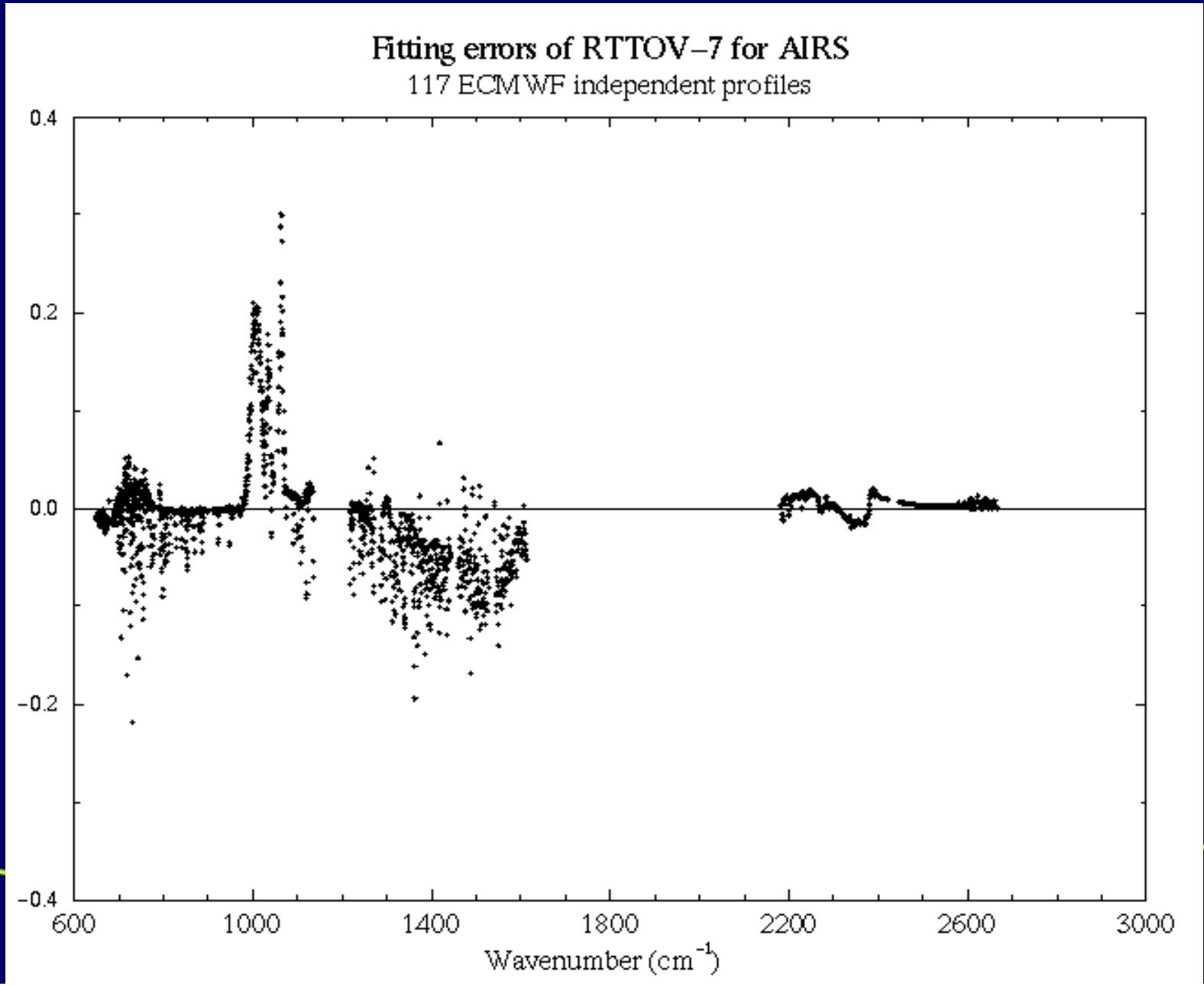
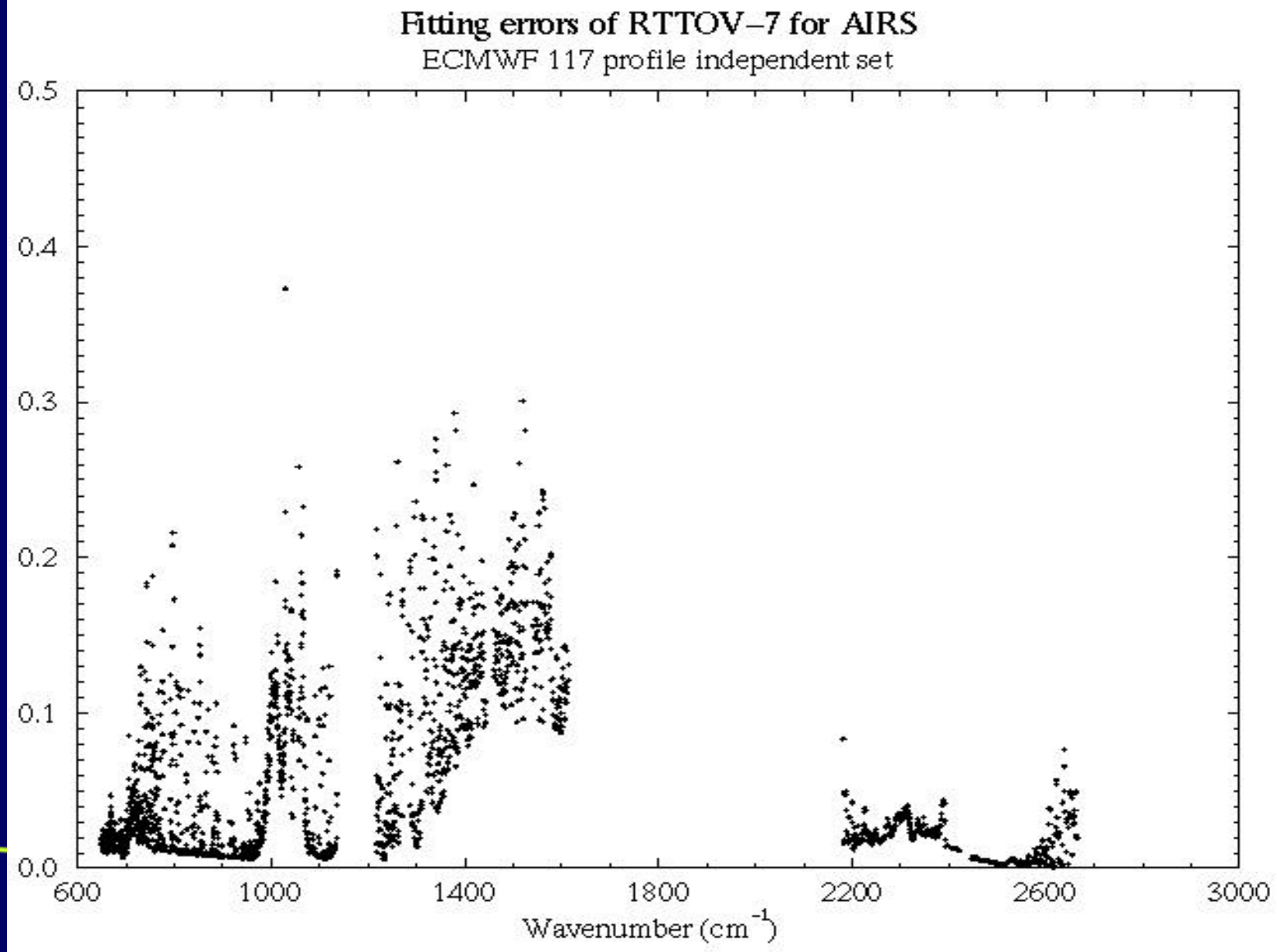
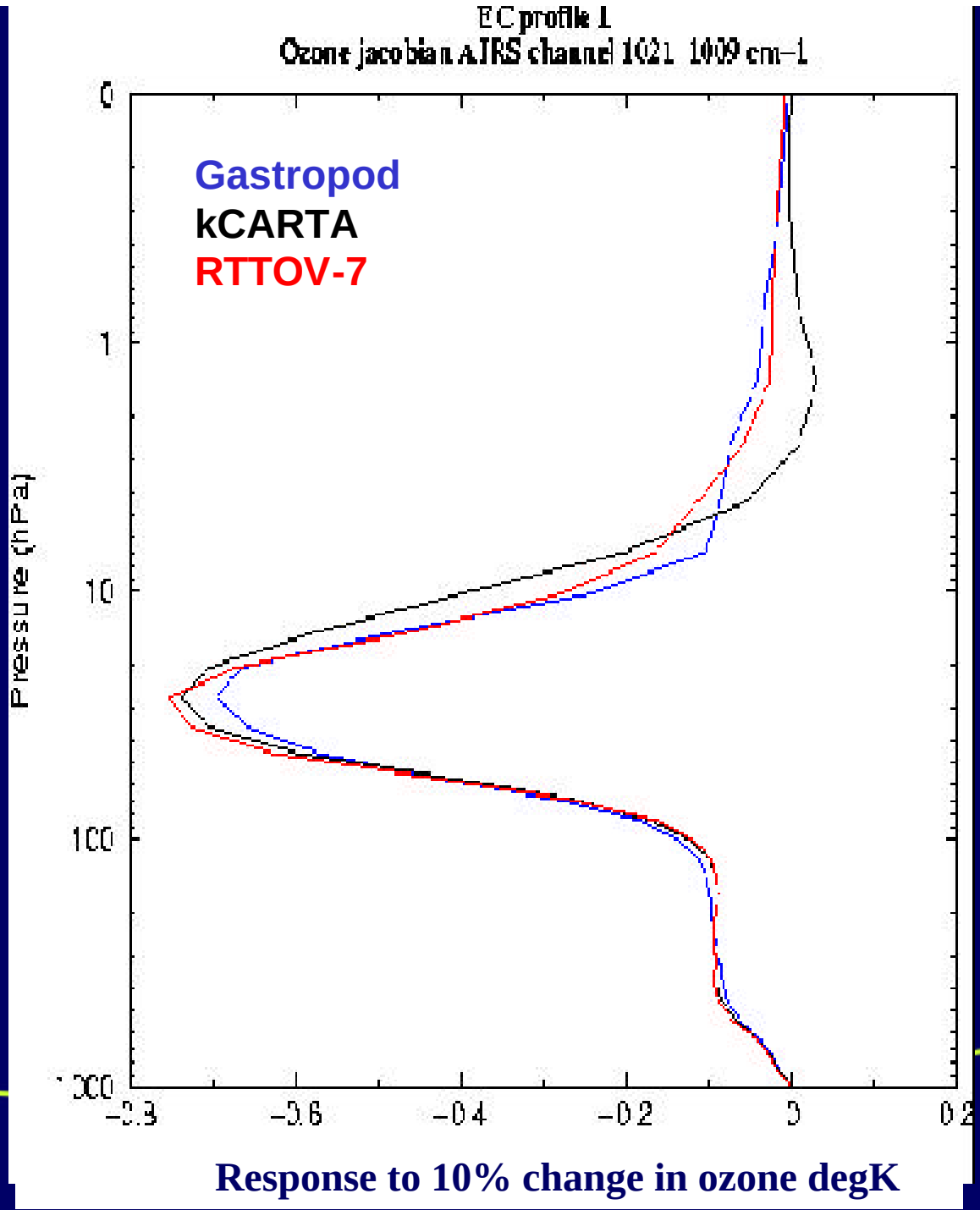
RT model validation



RT model validation





RTTOV-7 model validation for AIRS

Ozone jacobian

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Variational Cloud Detection

(English, Eyre & Smith, 1999)

Attempt to determine the probability of having cloud in the field of view given the observed radiances and the NWP background profile

$$J = -\mathrm{Ln}\{P(\mathrm{cloud} \mid \mathbf{y}_{\mathrm{obs}}, \mathbf{x}_{\mathrm{b}})\}$$

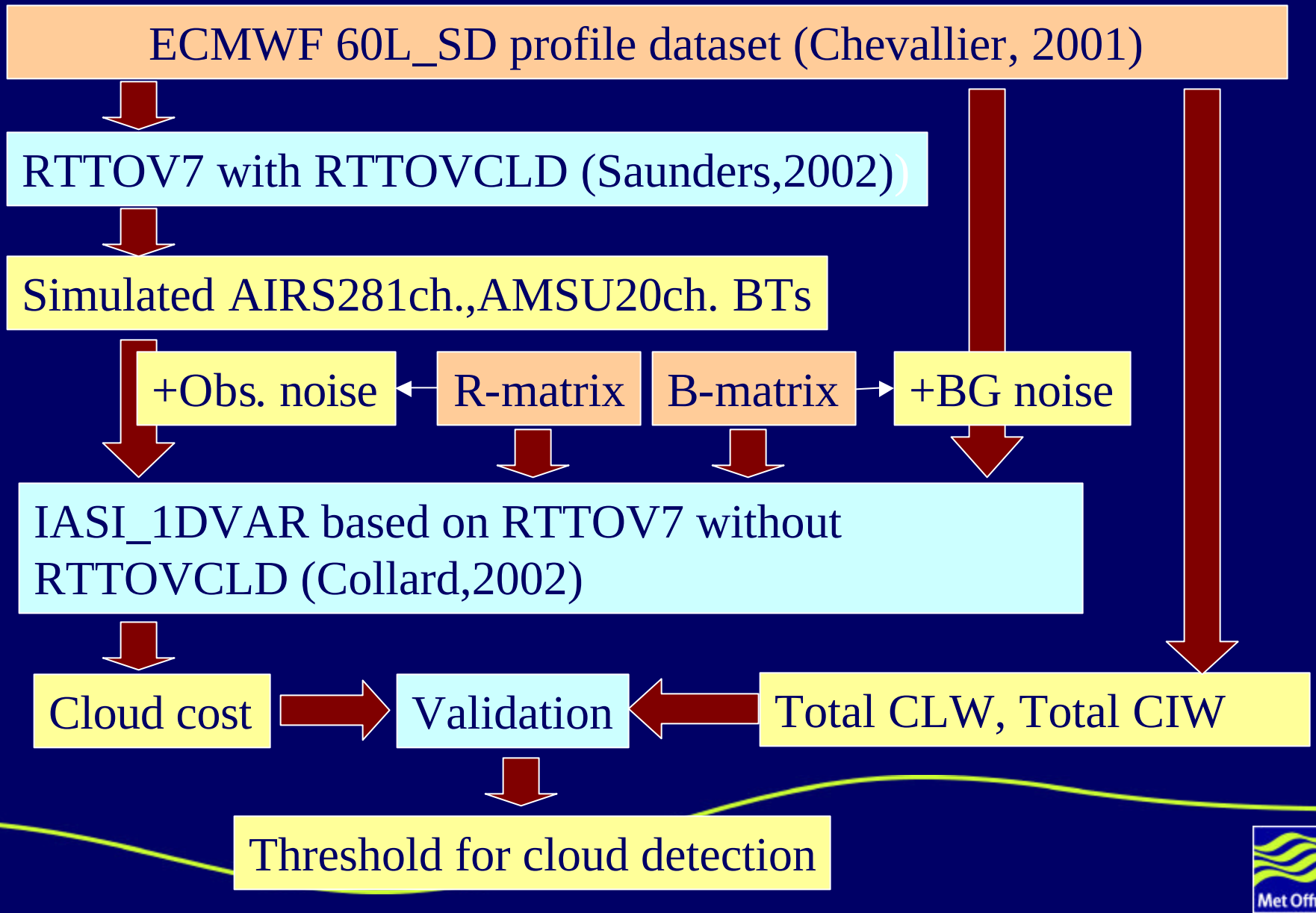
$$\sim -\tfrac{1}{2}(\Delta\mathbf{y})^{\mathrm{T}}\{\mathbf{H}(\mathbf{x}_{\mathrm{b}})^{\mathrm{T}}\mathbf{B}\mathbf{H}(\mathbf{x}_{\mathrm{b}}) + \mathbf{R}\}^{-1}(\Delta\mathbf{y}) + \mathrm{Const.}$$

$$\Delta\mathbf{y} = \mathbf{y}_{\mathrm{obs}} - \mathbf{y}(\mathbf{x}_{\mathrm{b}})$$

Clouds are flagged when *J* exceeds a threshold

In addition if O-B for chan 787 less than -2K flagged as cloudy

Methodology



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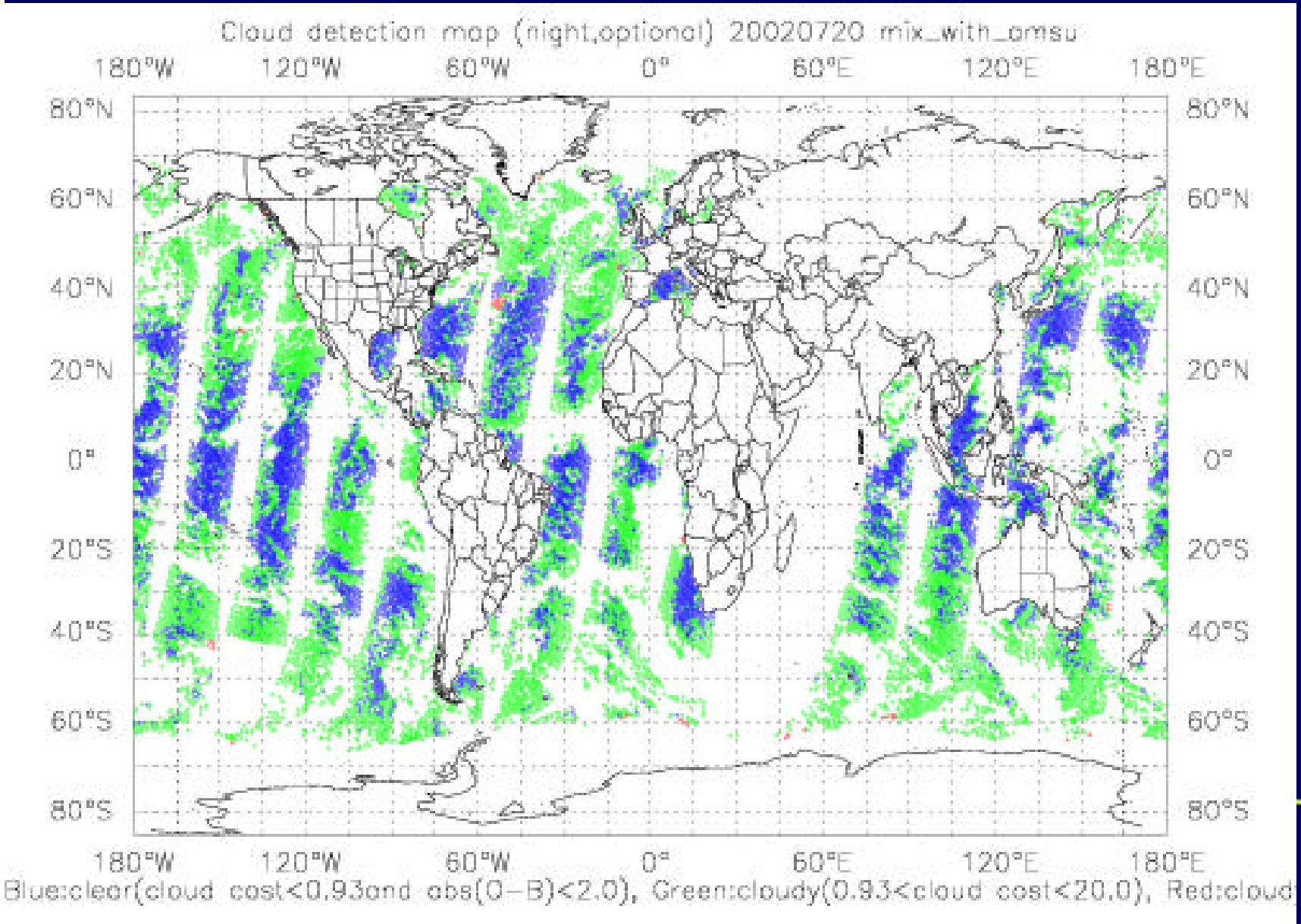
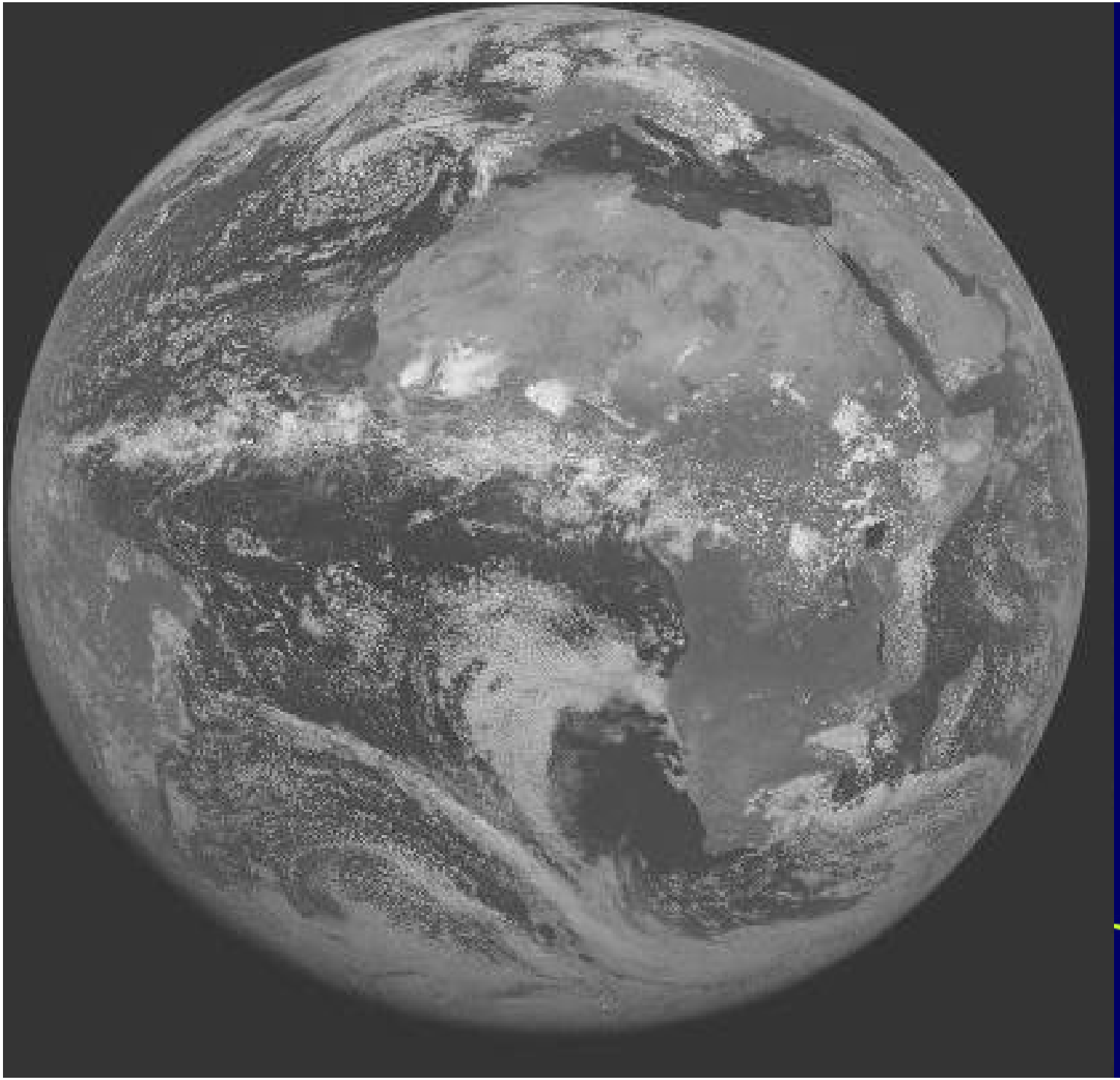
Preliminary channel selection for cloud cost calculation

Ch. 281	Ch. 2378	Wavenumber (cm^{-1})	Wavelength (micron)	
125	787	917.569	10.90	+ O-B check > -2K
127	843	938.183	10.66	
129	914	965.722	10.35	
159	1221	1115.06	8.96	
160	1237	1123.55	8.90	
271	2328	2611.84	3.83	
272	2333	2617.16	3.82	

AMSU ch.2 31.4GHz
ch.3 50.3GHz
ch.15 89.0GHz

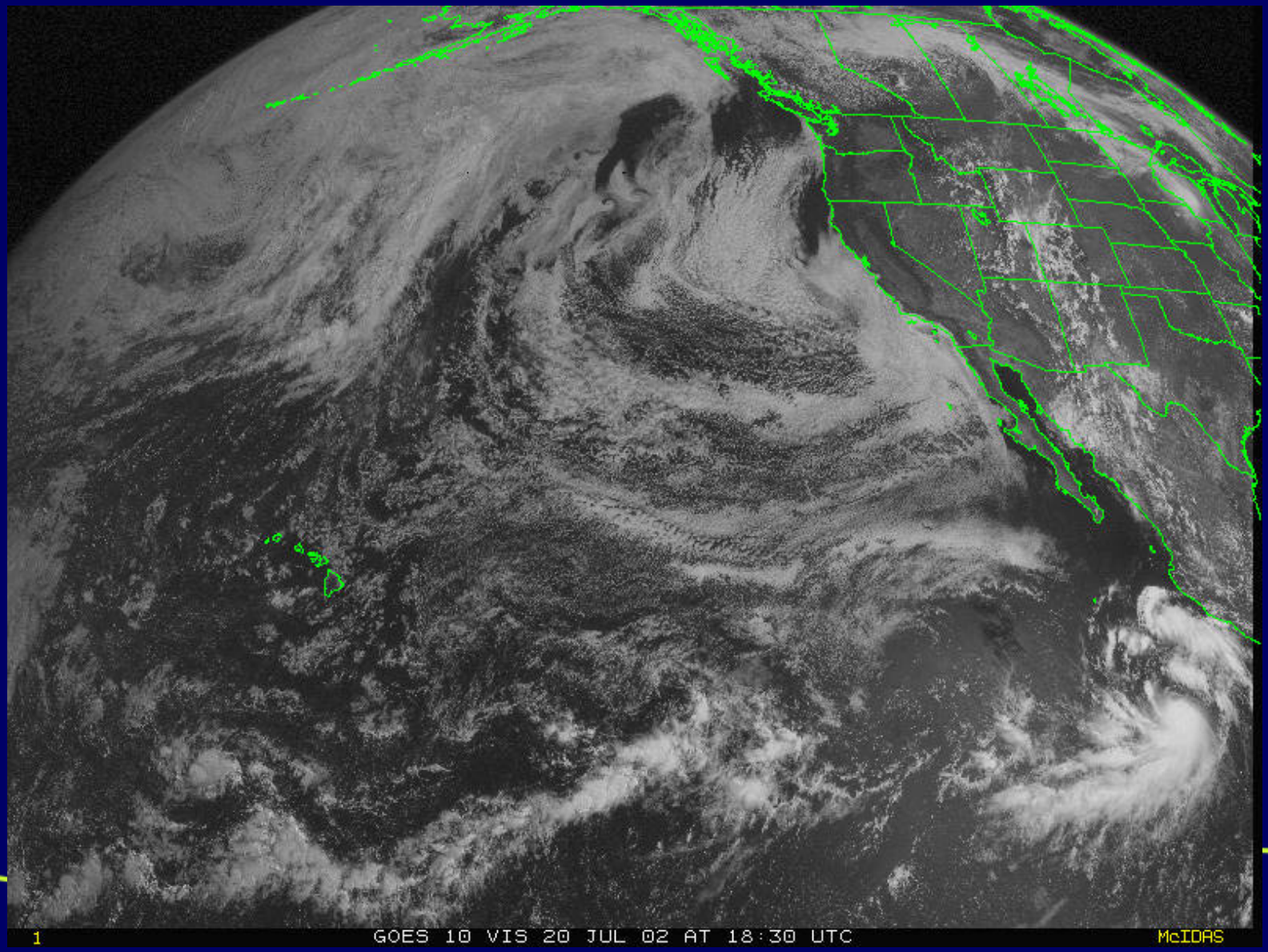
Cloud cost (night)



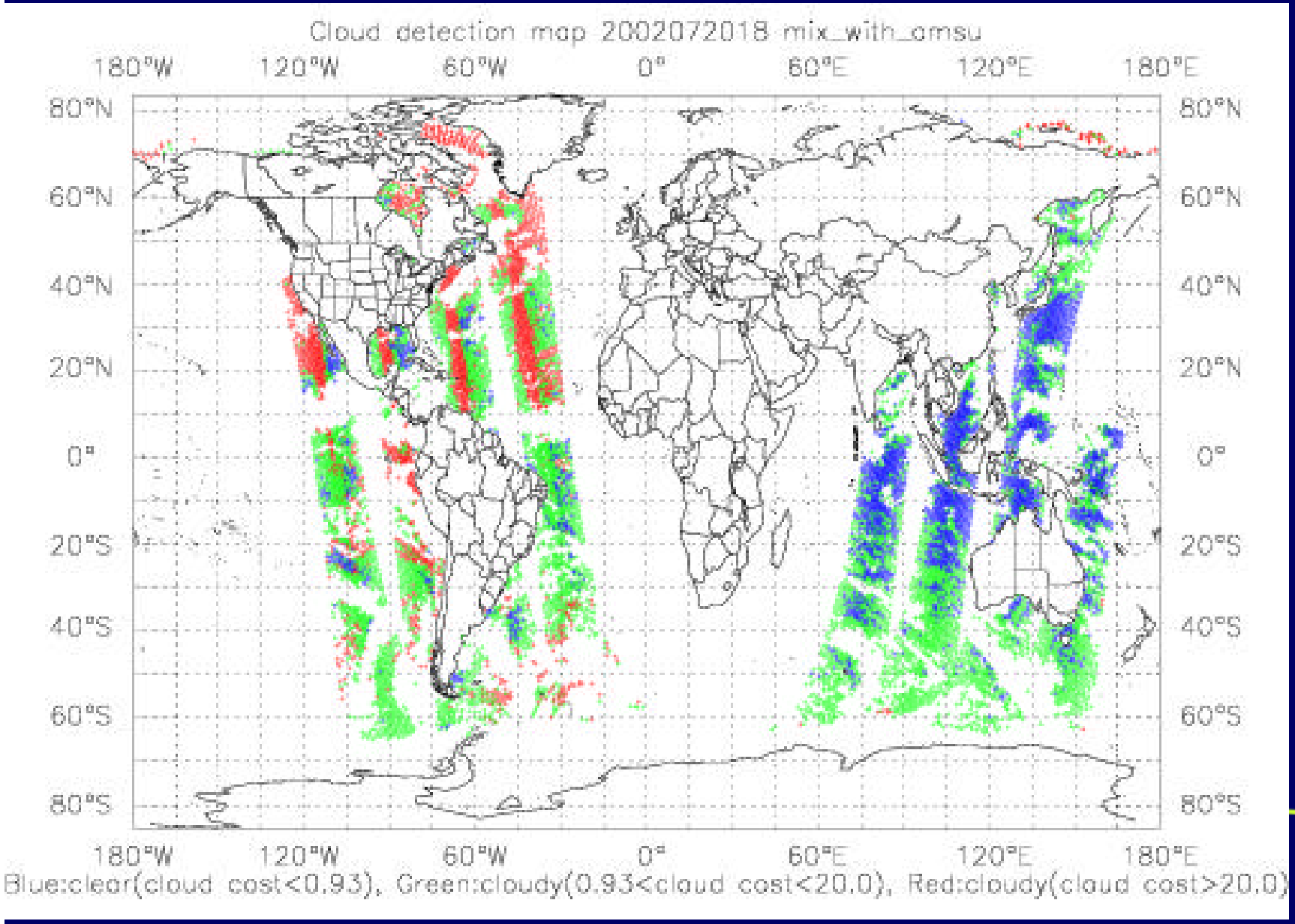


Meteosat
12Z 20 July

GOES validation



Cloud cost (day)



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Mitch's cloud detection

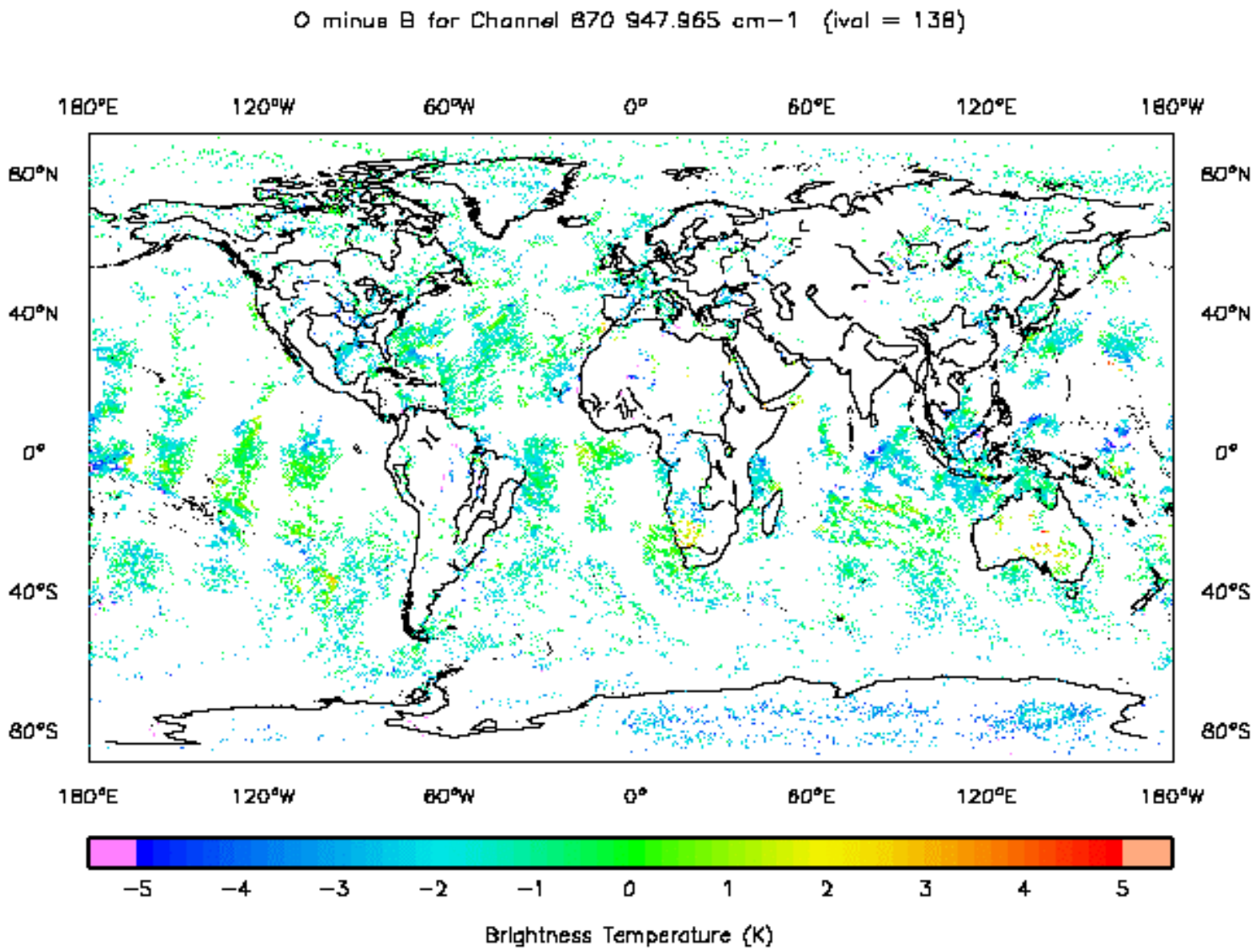
1. $AIRS_{2112} = 18.653 - 0.169 \times AMSU_4 + 1.975 \times AMSU_5 - 0.865 \times AMSU_6$
   $+ 0.608 \times \cos(solzen) + 4.529 \times (1-\cos(scan))$
   $test1A = AIRS_{2112} - AIRS_{2112}$ (green is measured)
2. $test1B = AIRS_{2226} - AIRS_{843}$
3. $SST = 8.28206 - 0.97957 \times AIRS_{791} + 0.60529 \times AIRS_{914}$
   $+ 1.74444 \times AIRS_{1285} - 0.40379 \times AIRS_{1301}$
   $test_{SST} = SST - SST$ (red is from NWP model SST)

IF($test1A < 2$ and $test1B < 5$ and $test_{SST} > 2$ and $test_{SST} < 4$)

Then fov is clear

Compare Mitch's tests with Var

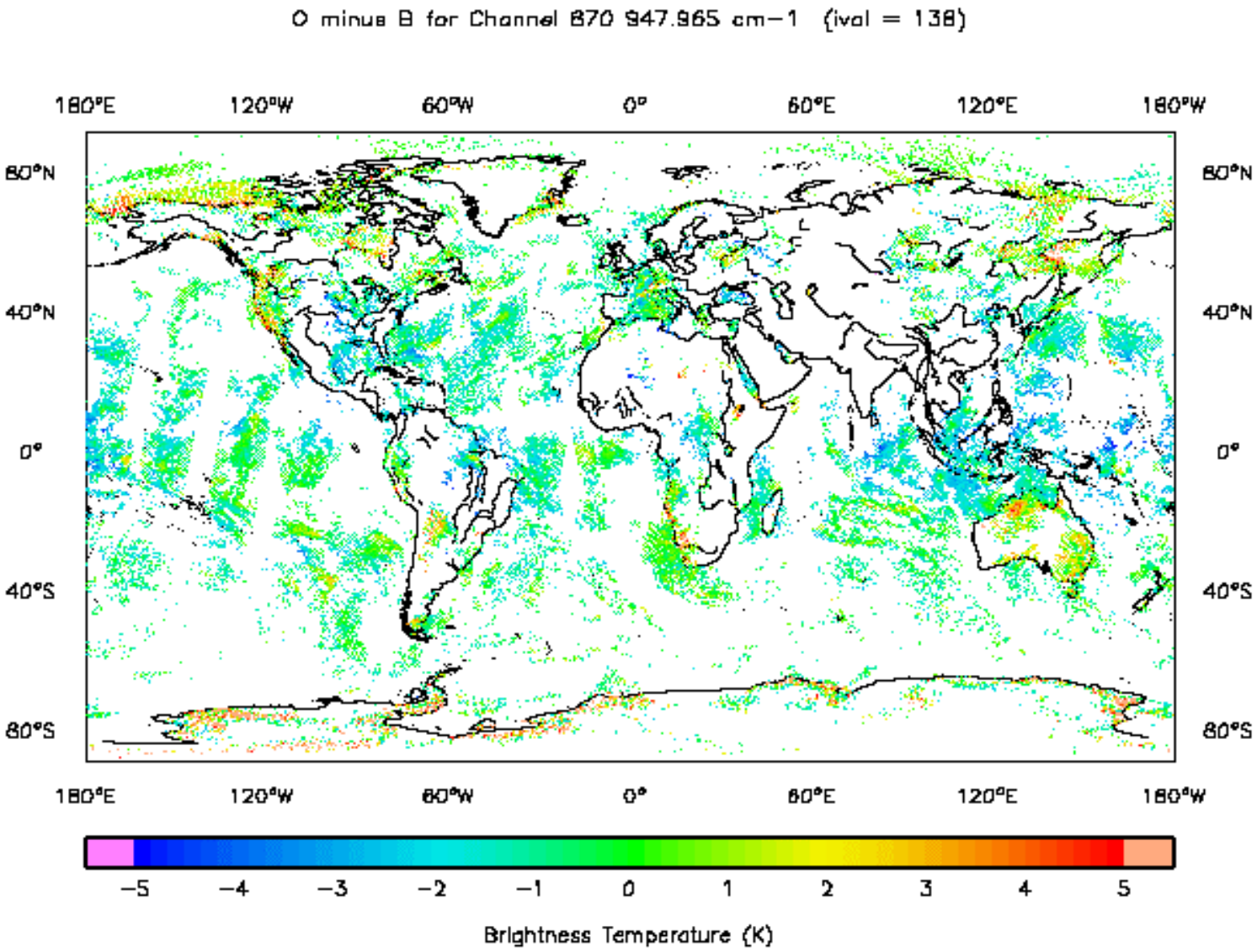
Mitch's cloud test



12% clear

Compare Mitch's tests with Var

Var cloud test



19% clear

NWP radiance monitoring

- Continuous global view of data
- Good for spotting sudden changes in instruments

- Can compare with other satellites and in situ obs
- But NWP model has errors: (LST, wv, ozone, clouds) so bias correction and cloud detection important and care in interpretation

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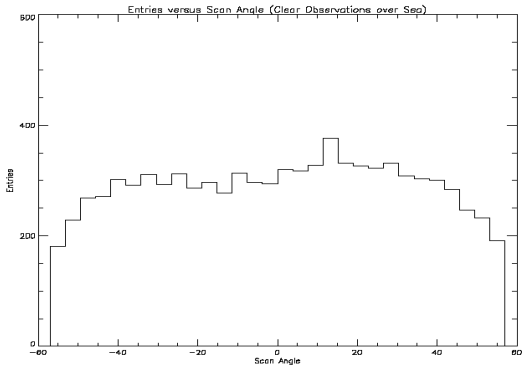
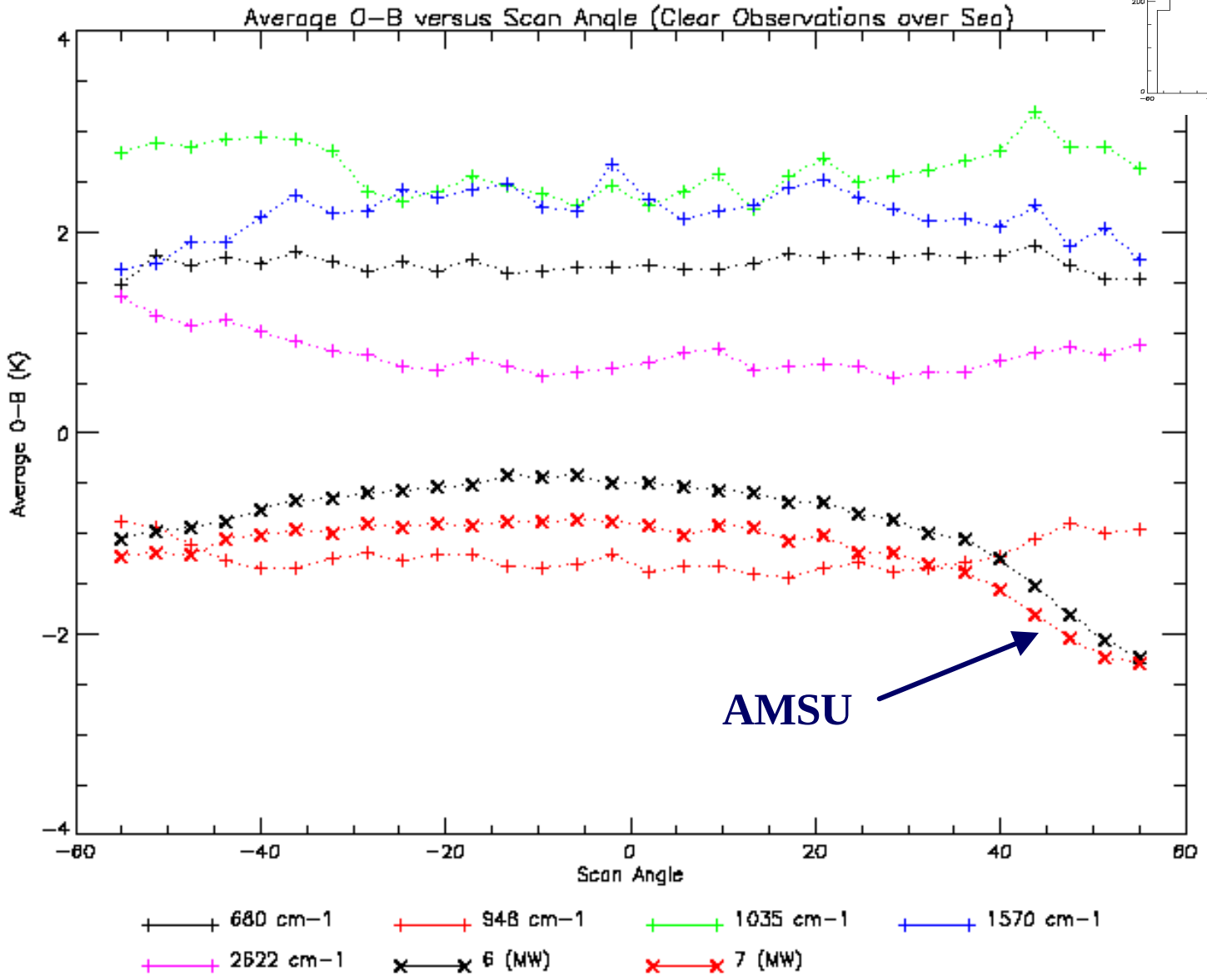
Plots of Observed-Background
Preliminary

- Scan biases for AIRS channels
- Compare NOAA-16 and AQUA
- Global maps for a few channels (inc AMSU-A)
- O-B clear histograms
- ‘Tartan’ plots from pole to pole
- Spectral plots for a few diverse atmosphere

Scan angle O-B plot





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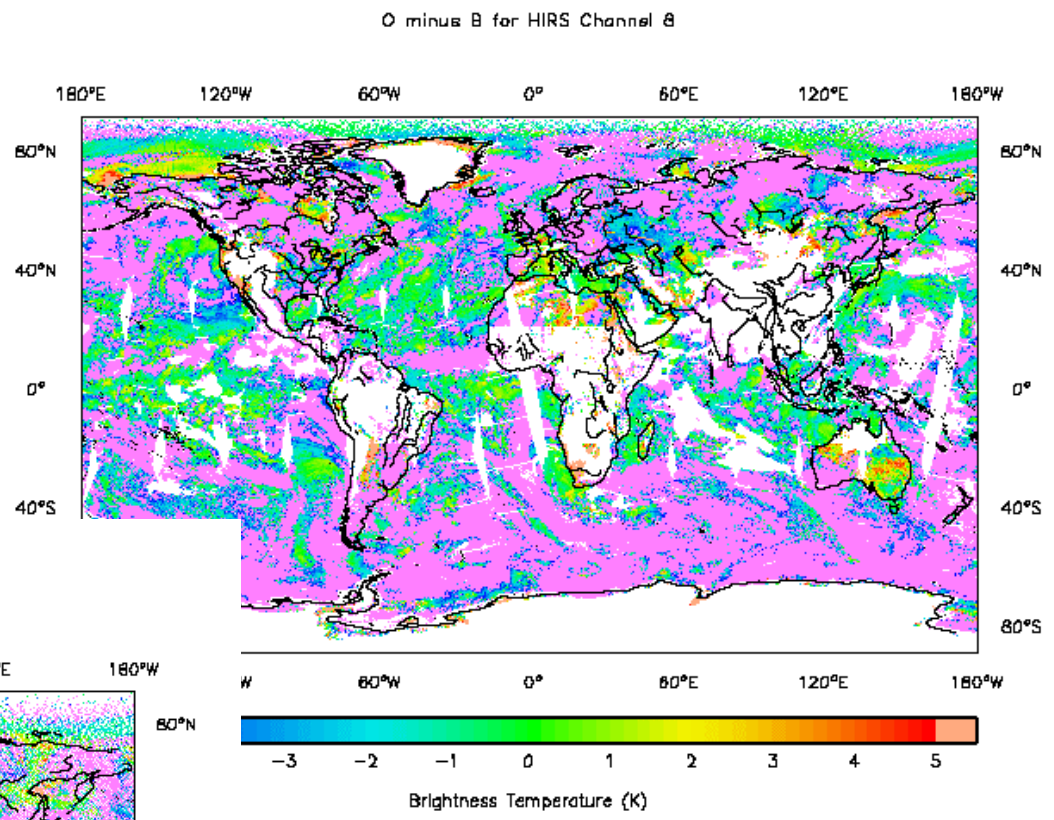
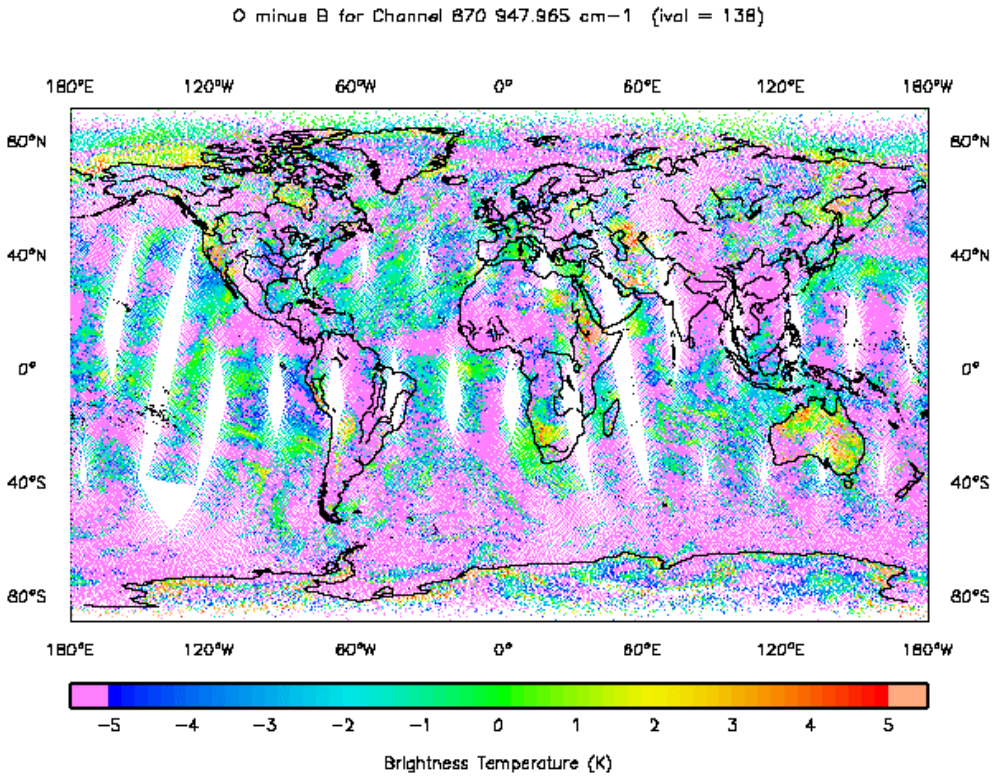
NOAA-16 vs AQUA

AIRS-843





HIRS-8

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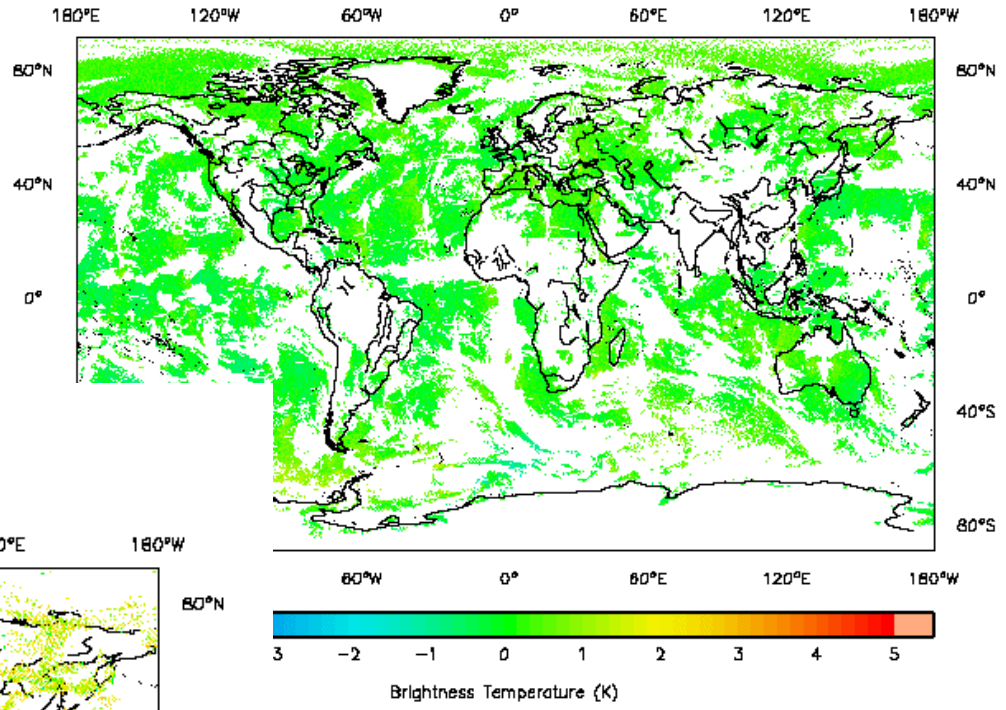
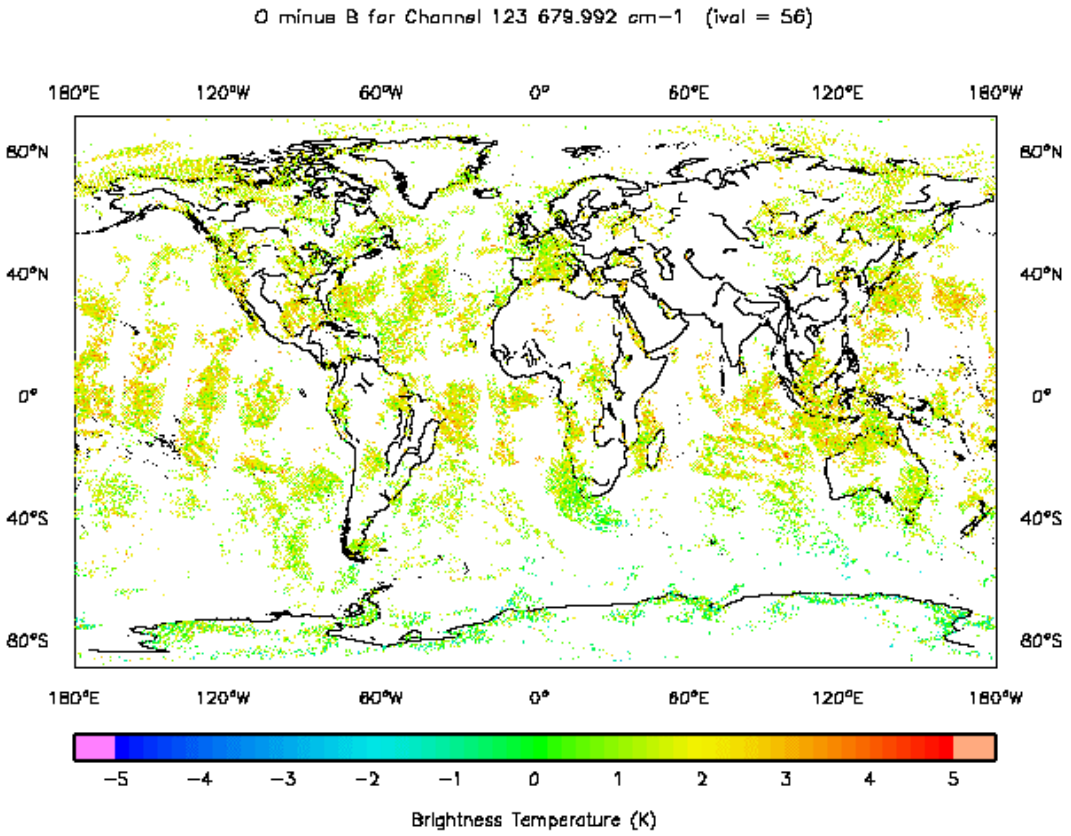
NOAA-16 vs AQUA

HIRS-2





O-B ‘clear’ maps

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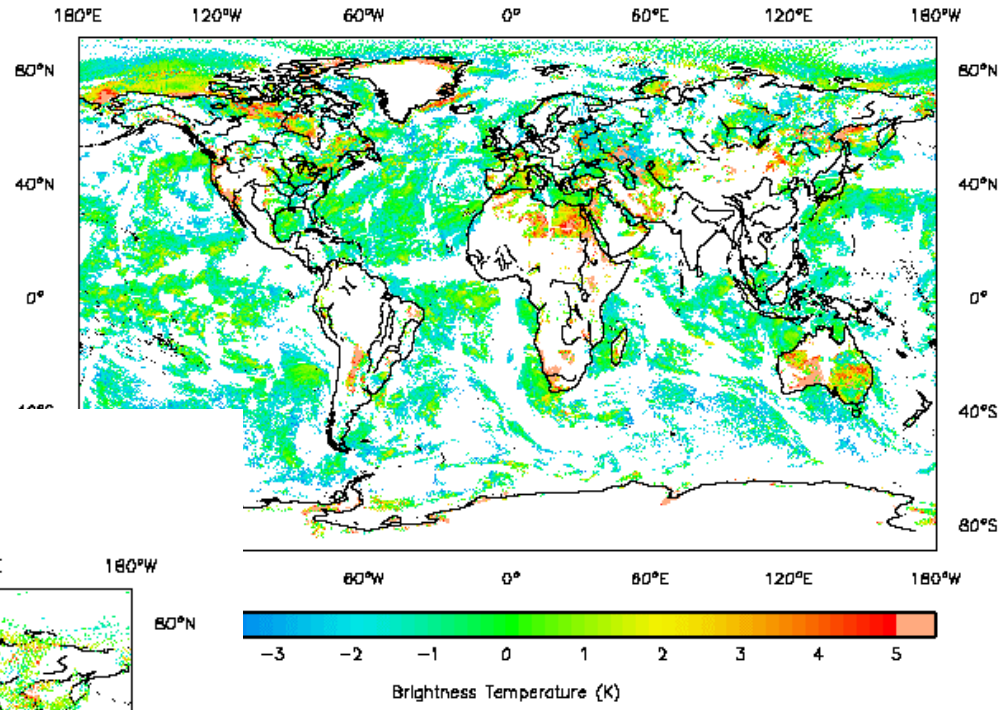
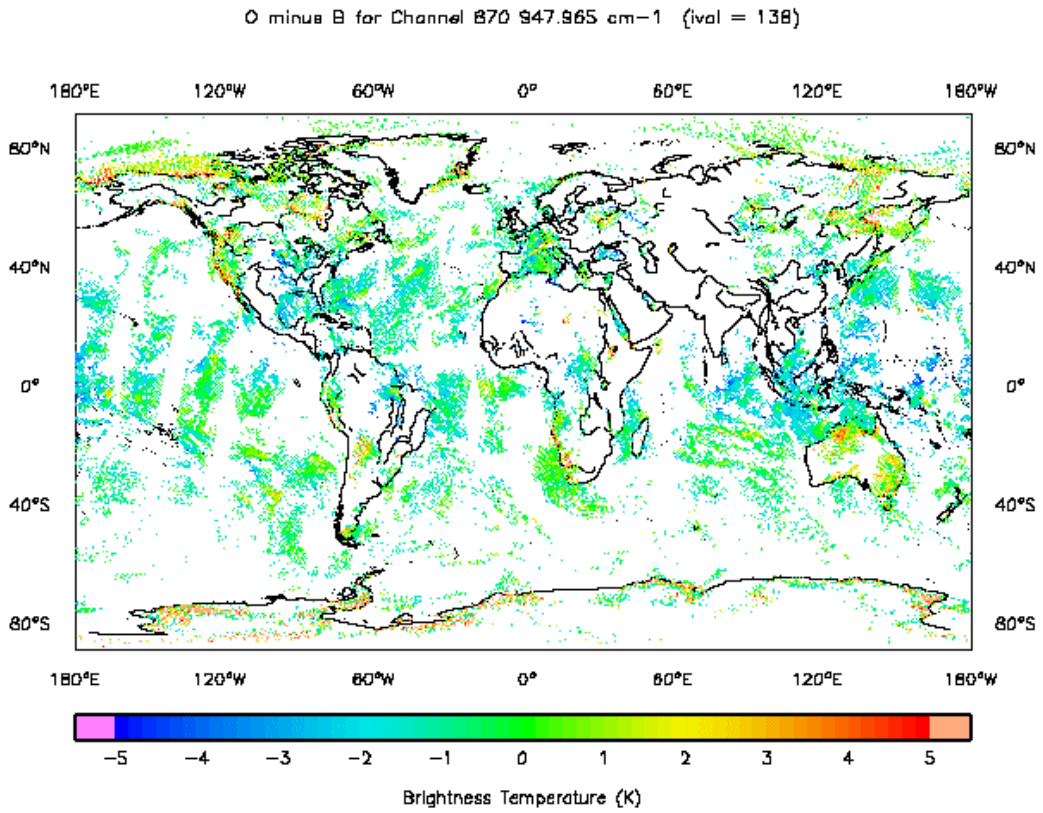
NOAA-16 vs AQUA

HIRS-8





O-B ‘clear’ maps

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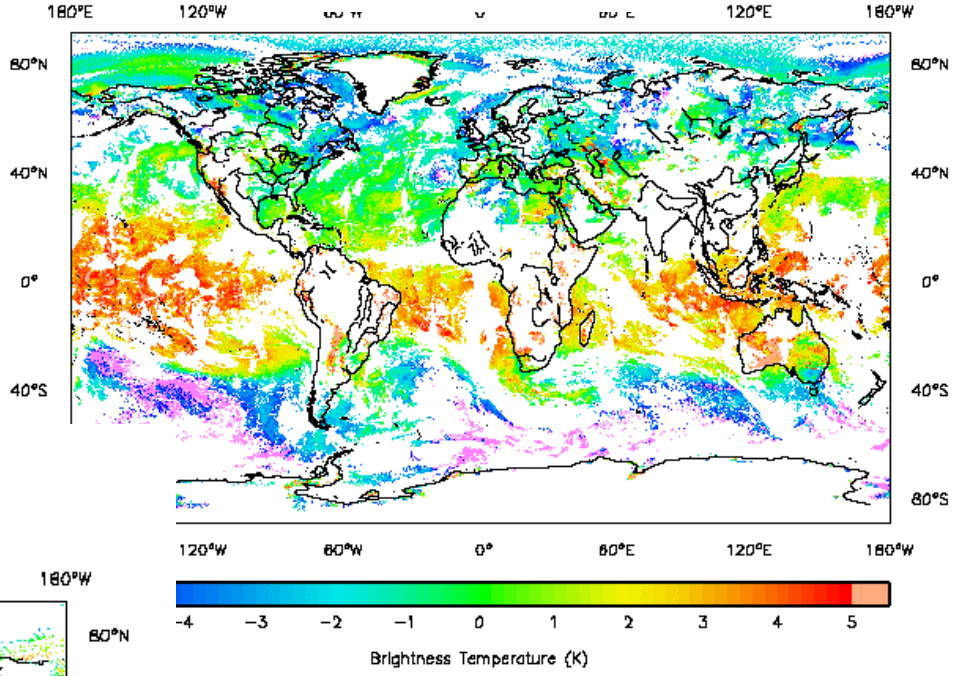
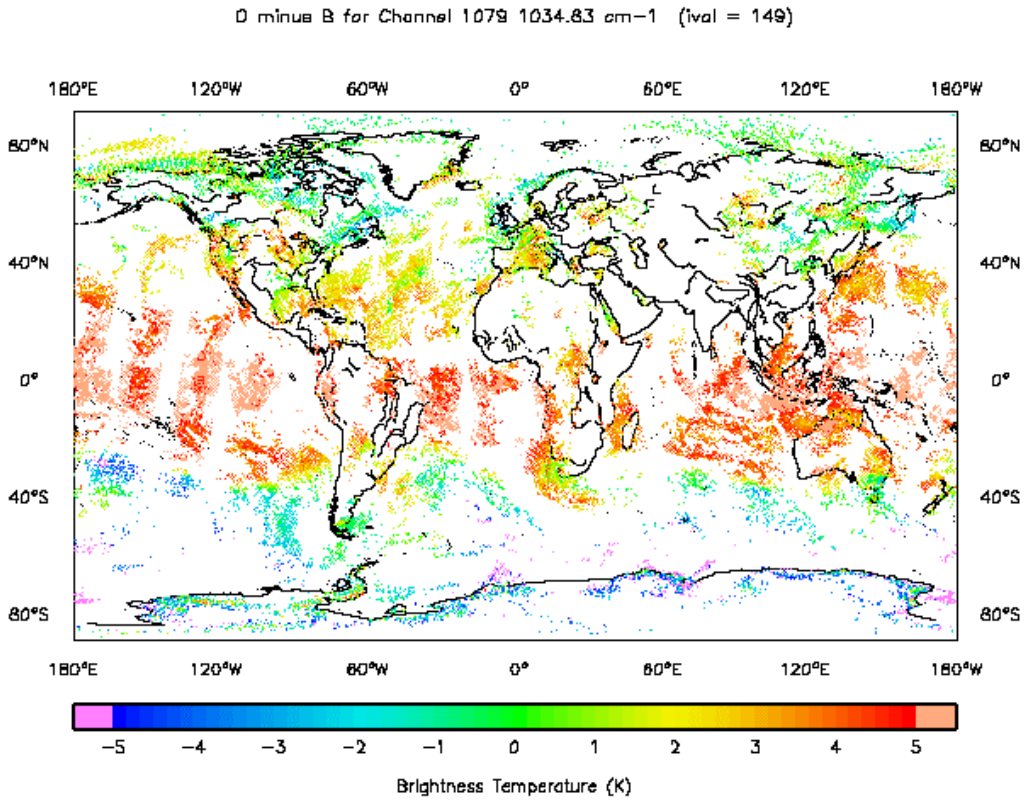
NOAA-16 vs AQUA

HIRS-9





O-B ‘clear’ maps

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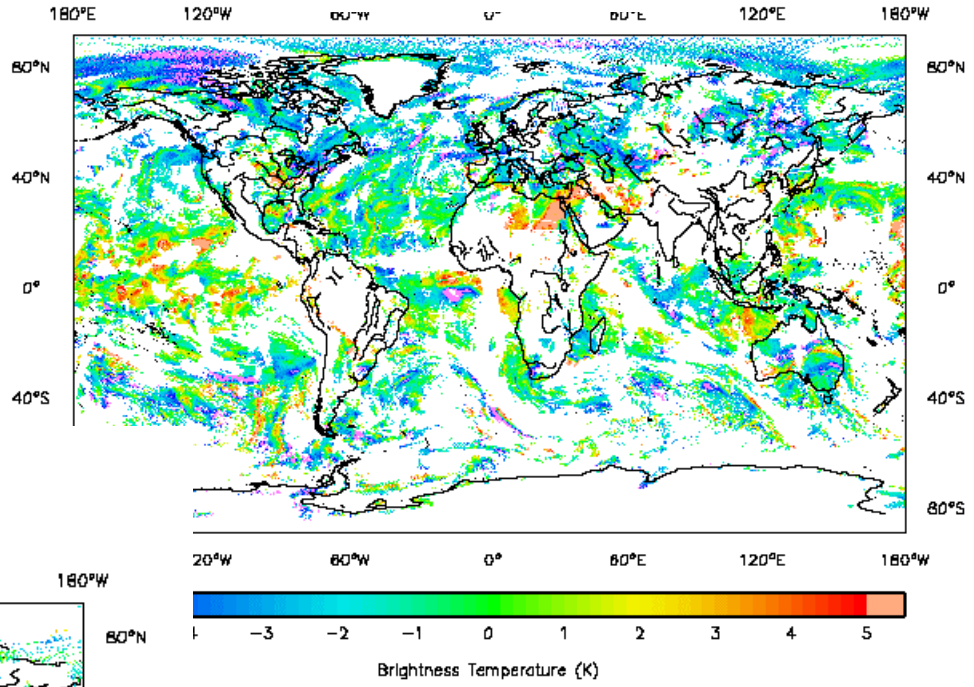
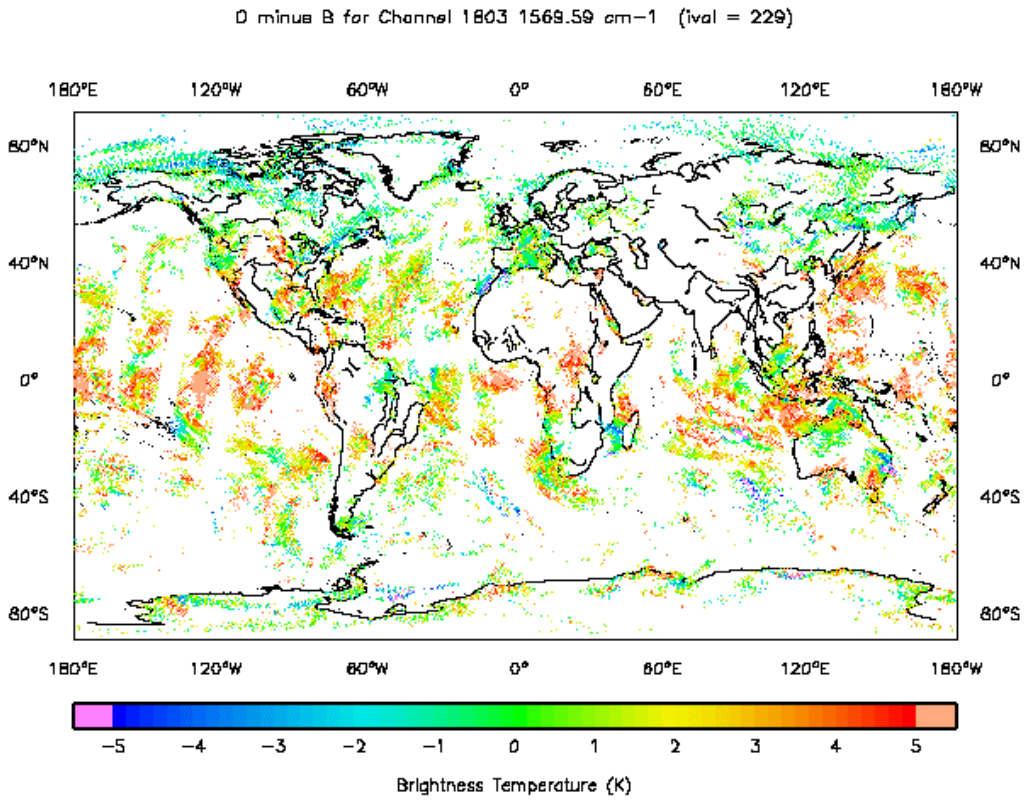
NOAA-16 vs AQUA

HIRS-12





O-B ‘clear’ maps

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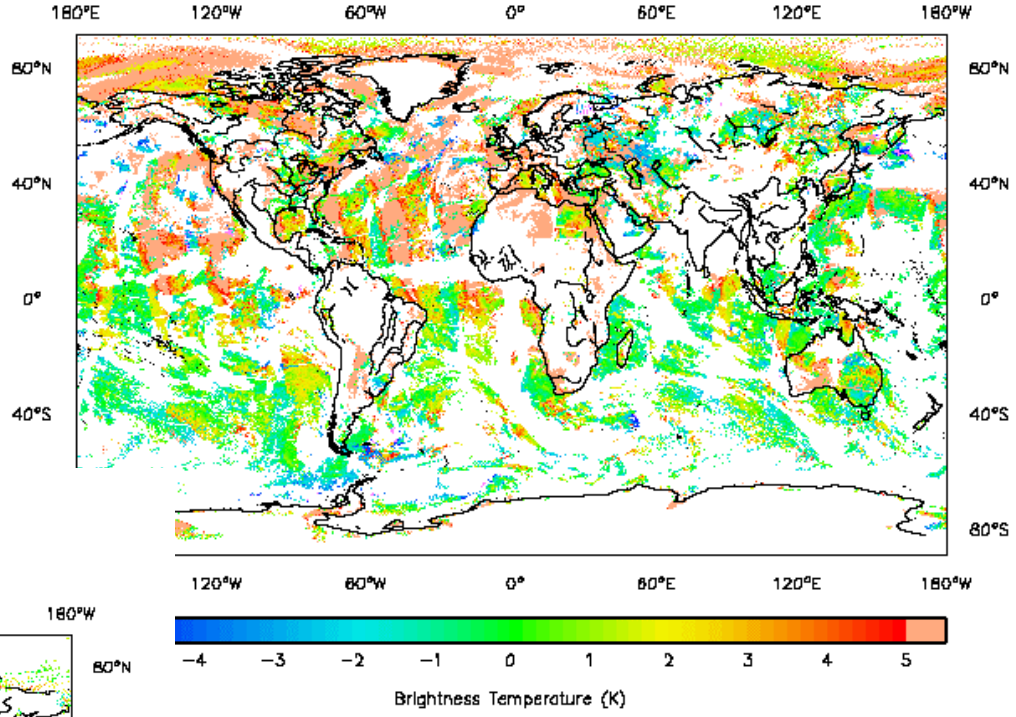
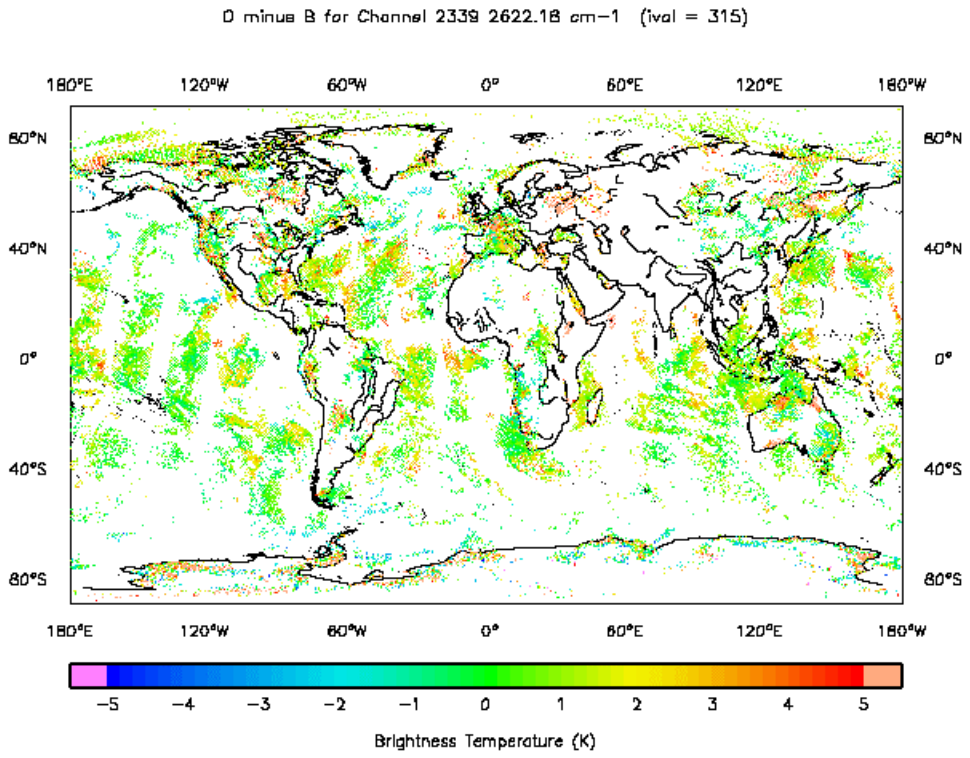
NOAA-16 vs AQUA

HIRS-19





O-B ‘clear’ maps

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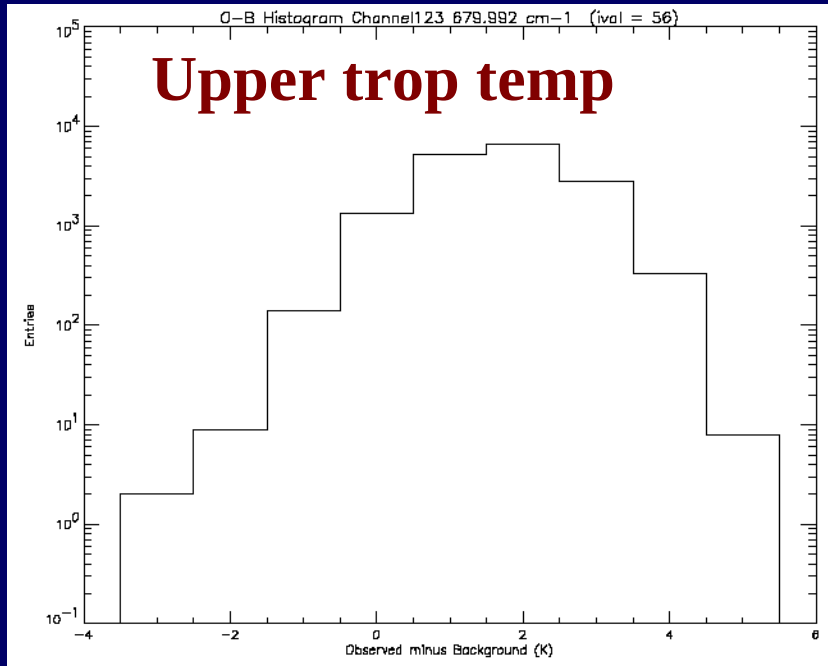
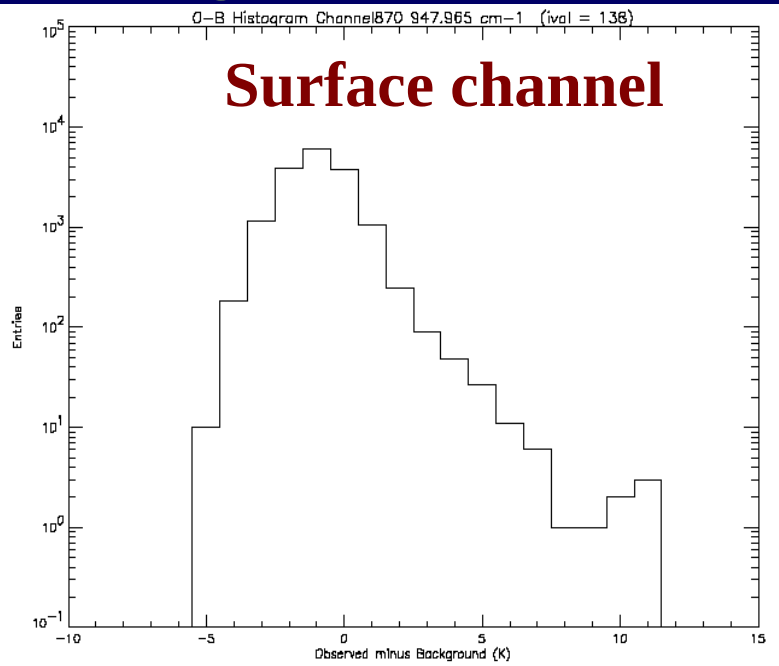
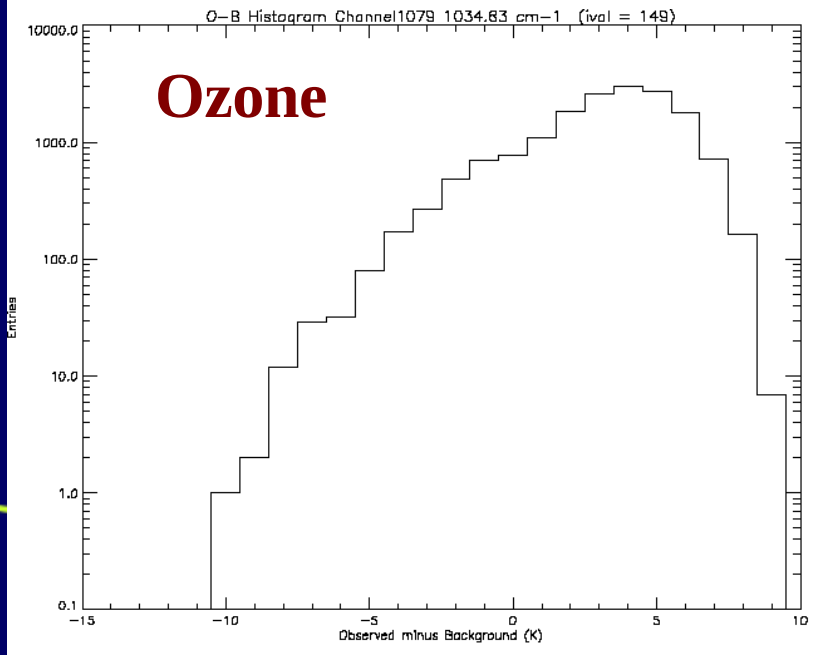
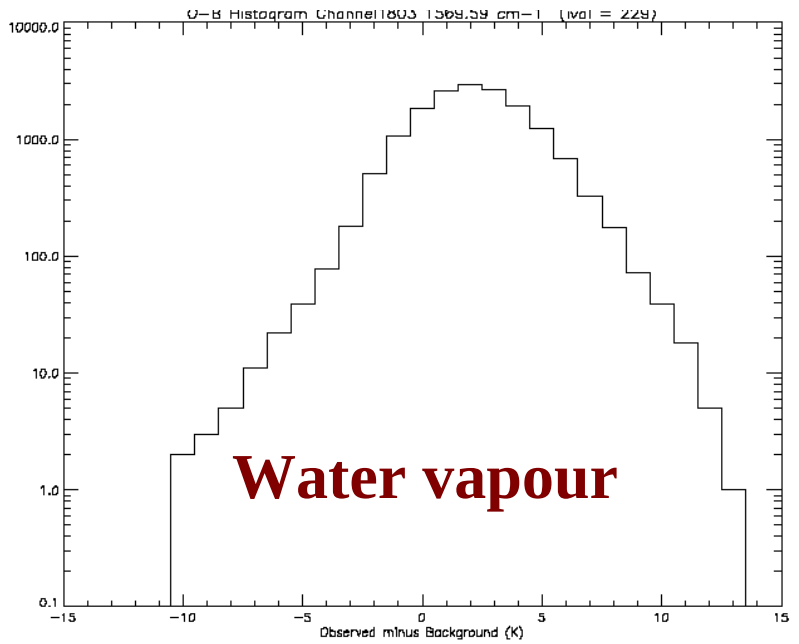
O-B clear histograms



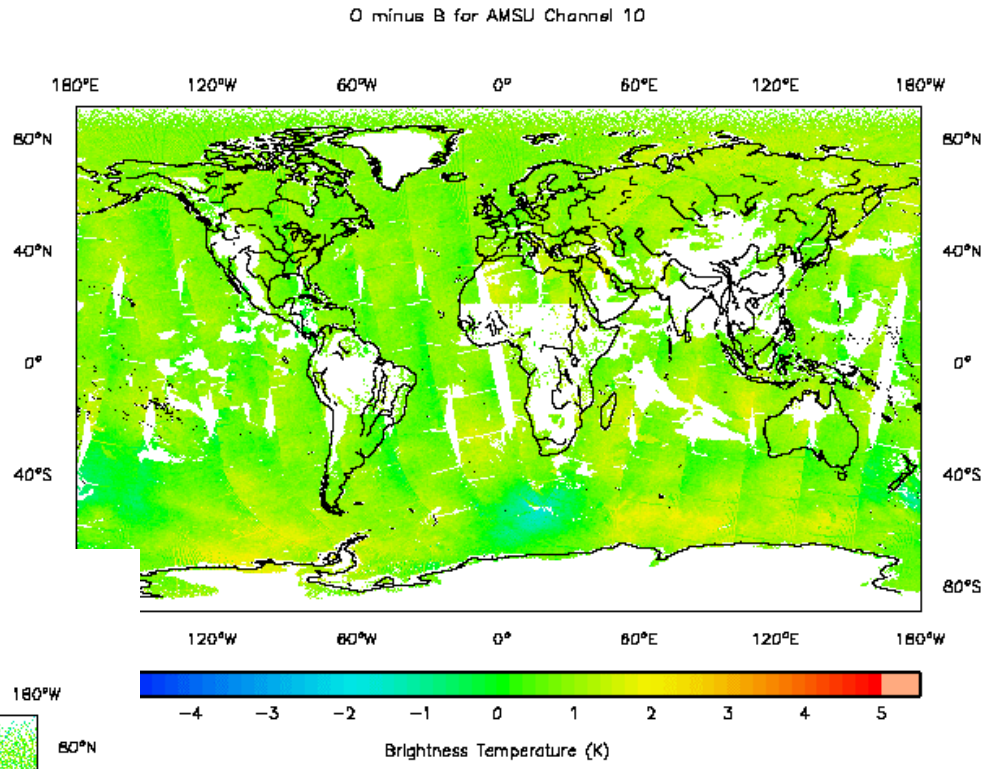


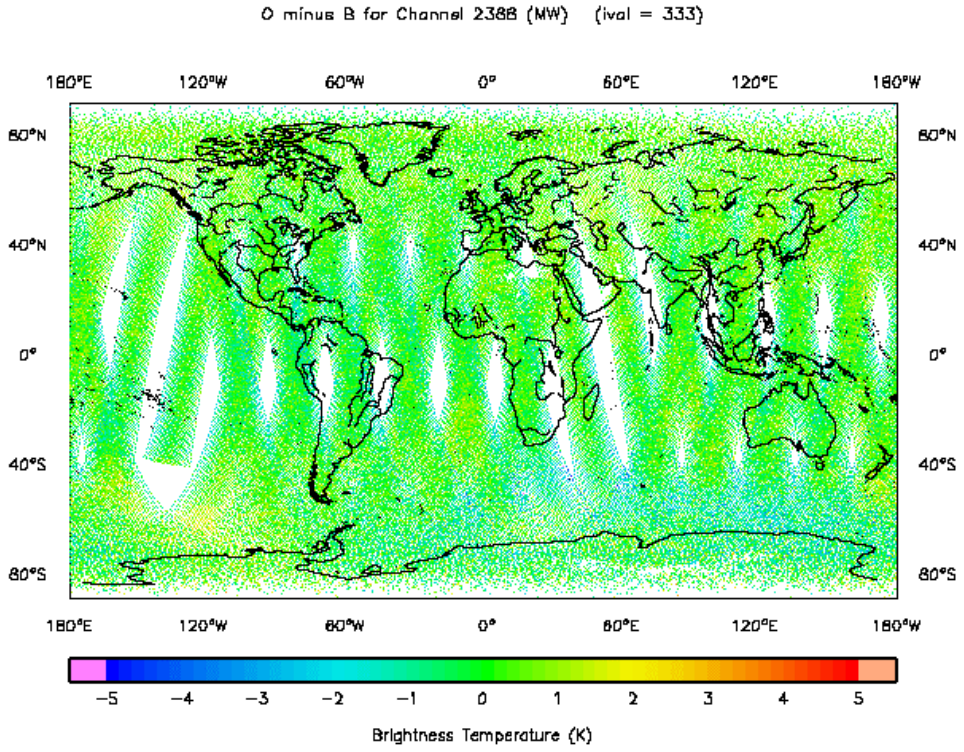




AMSU-10

AQUA





NOAA-16

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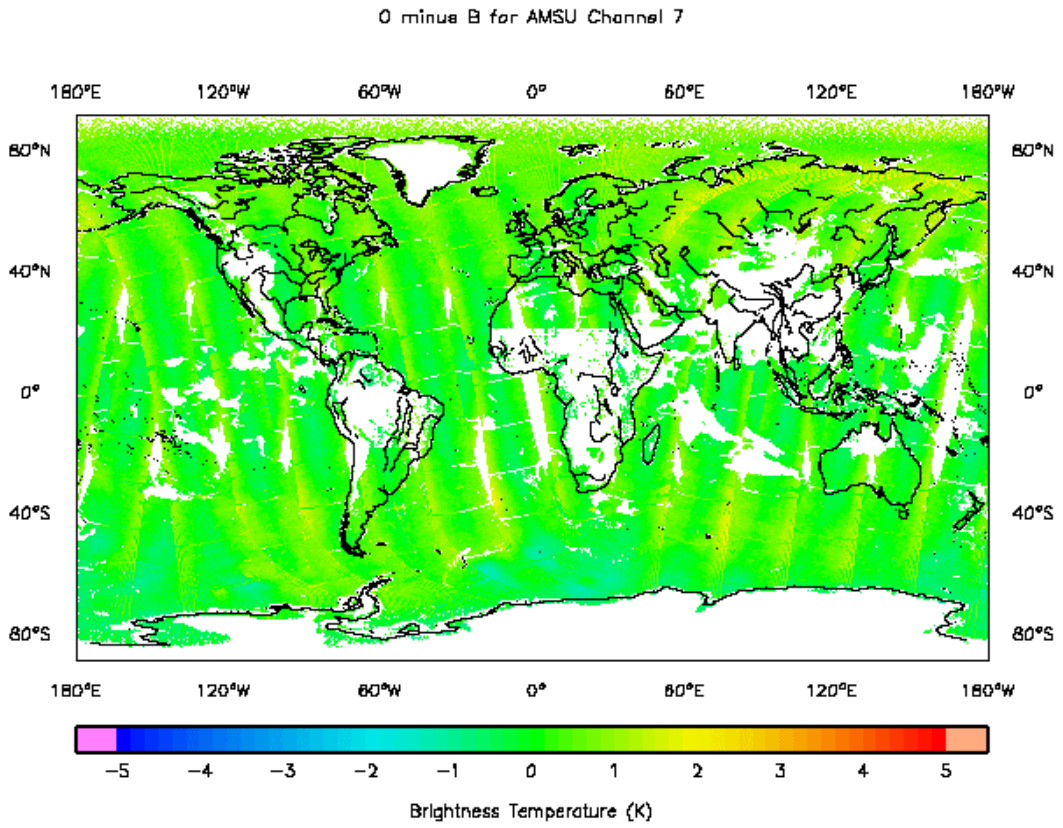
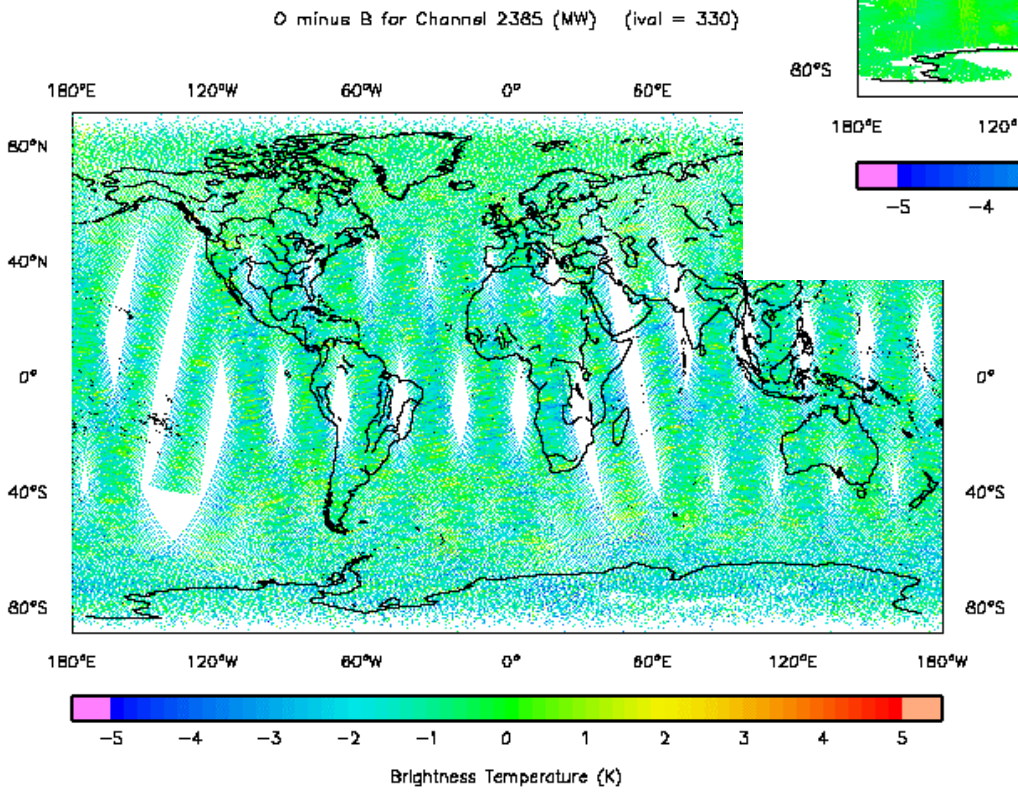
AMSU-7

AQUA





NOAA-16

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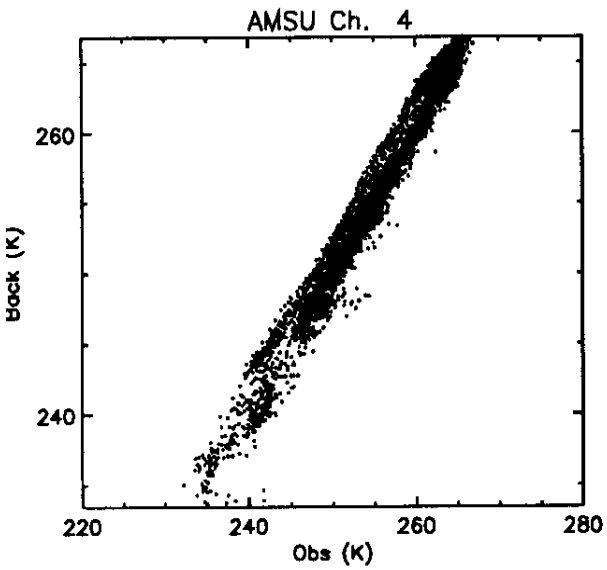
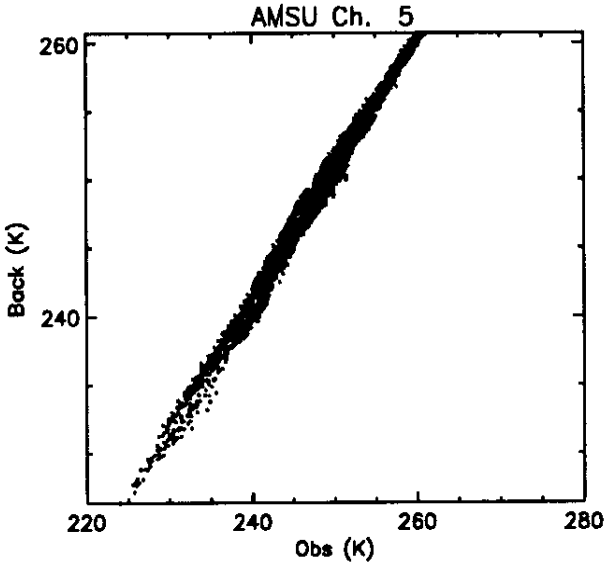
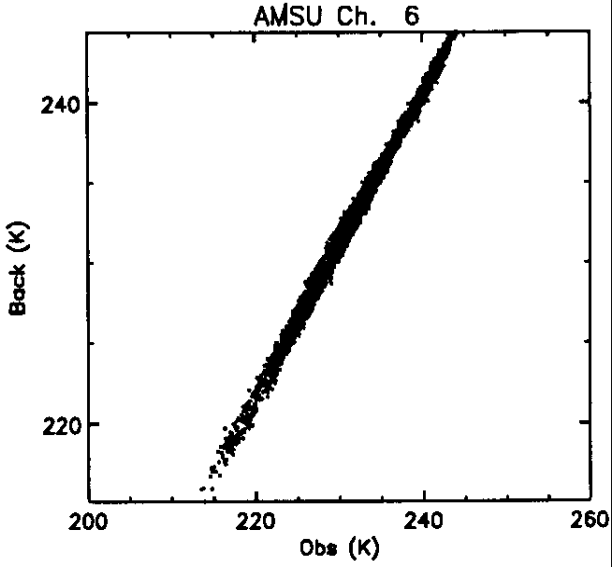
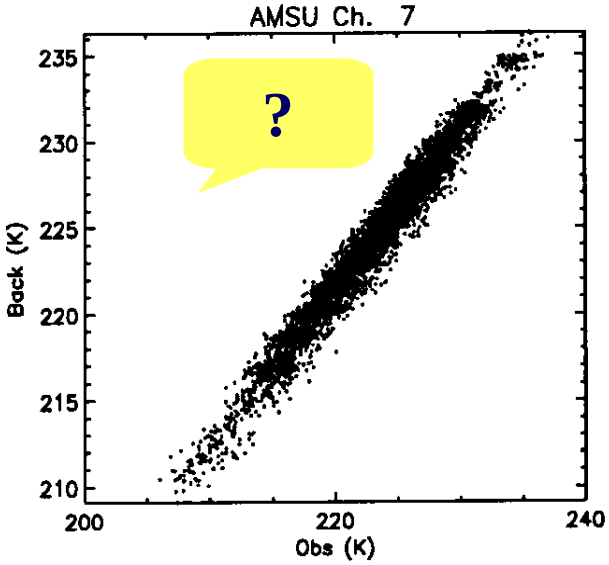
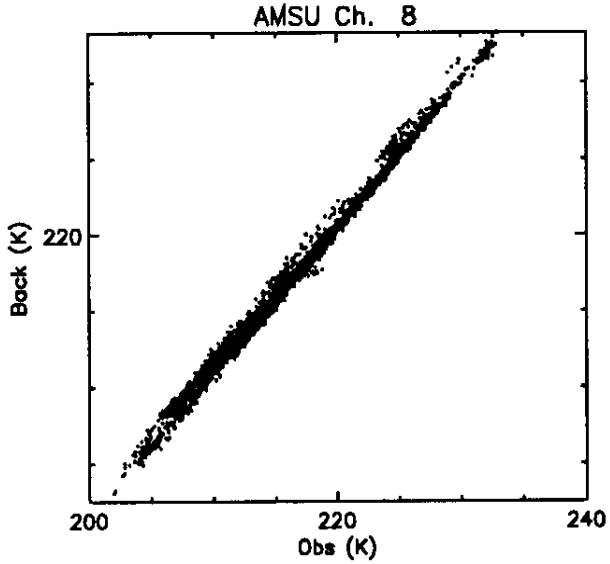
Aqua AMSU O-B

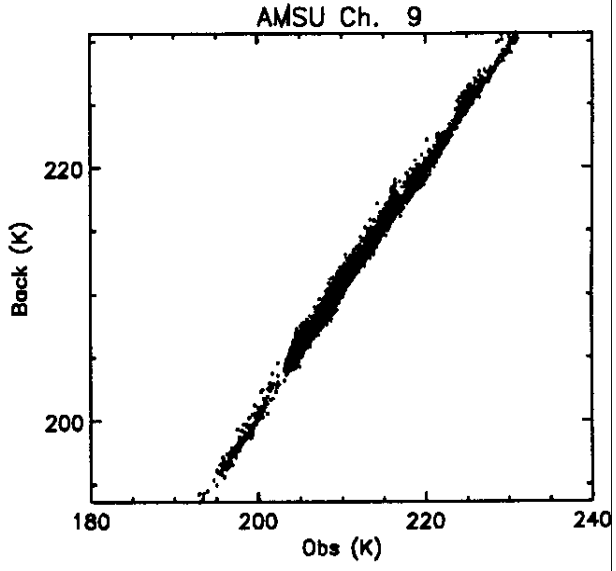

AMSU Ch. 4
Back (K)
Obs (K)
220
240
260
280


AMSU Ch. 5
Back (K)
Obs (K)
220
240
260
280

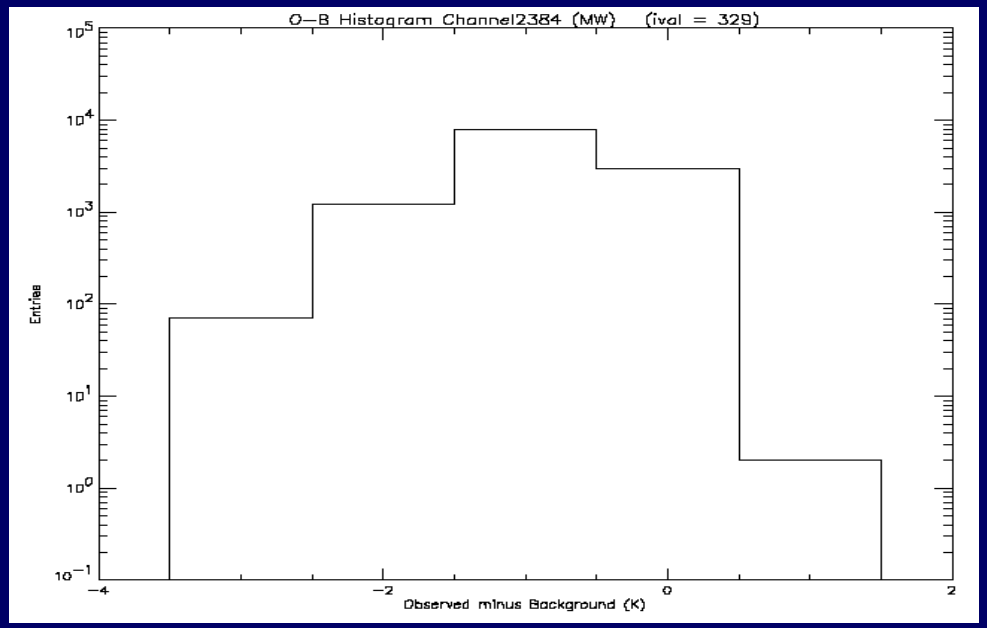

AMSU Ch. 6
Back (K)
Obs (K)
200
220
240
260


AMSU Ch. 7
?
Back (K)
Obs (K)
210
215
220
225
230
235
200
220
240

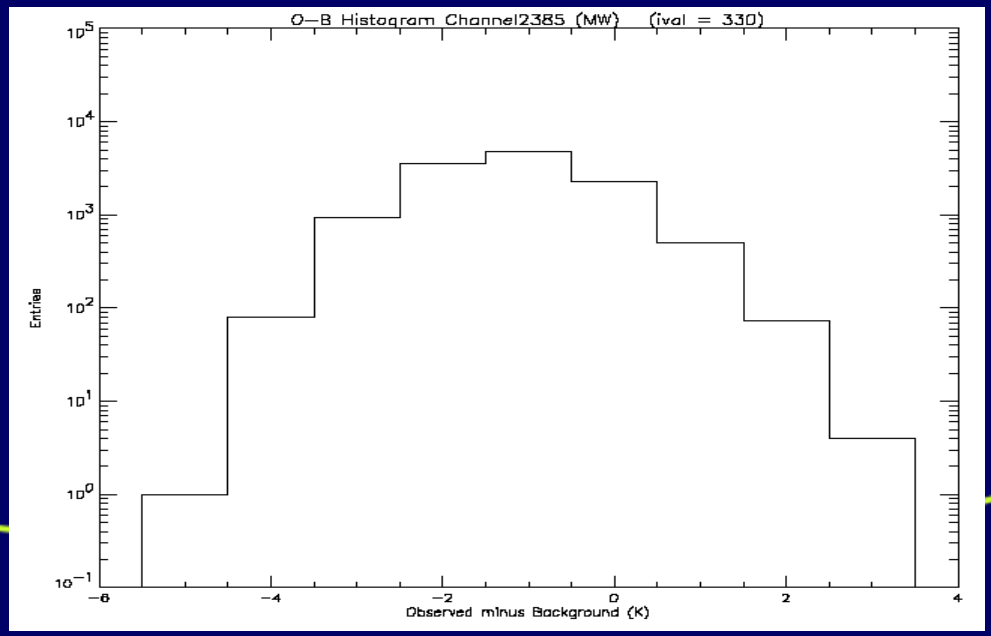

AMSU Ch. 8
Back (K)
Obs (K)
200
220
240


AMSU Ch. 9
Back (K)
Obs (K)
180
200
220
240

AMSU-A O-B histograms

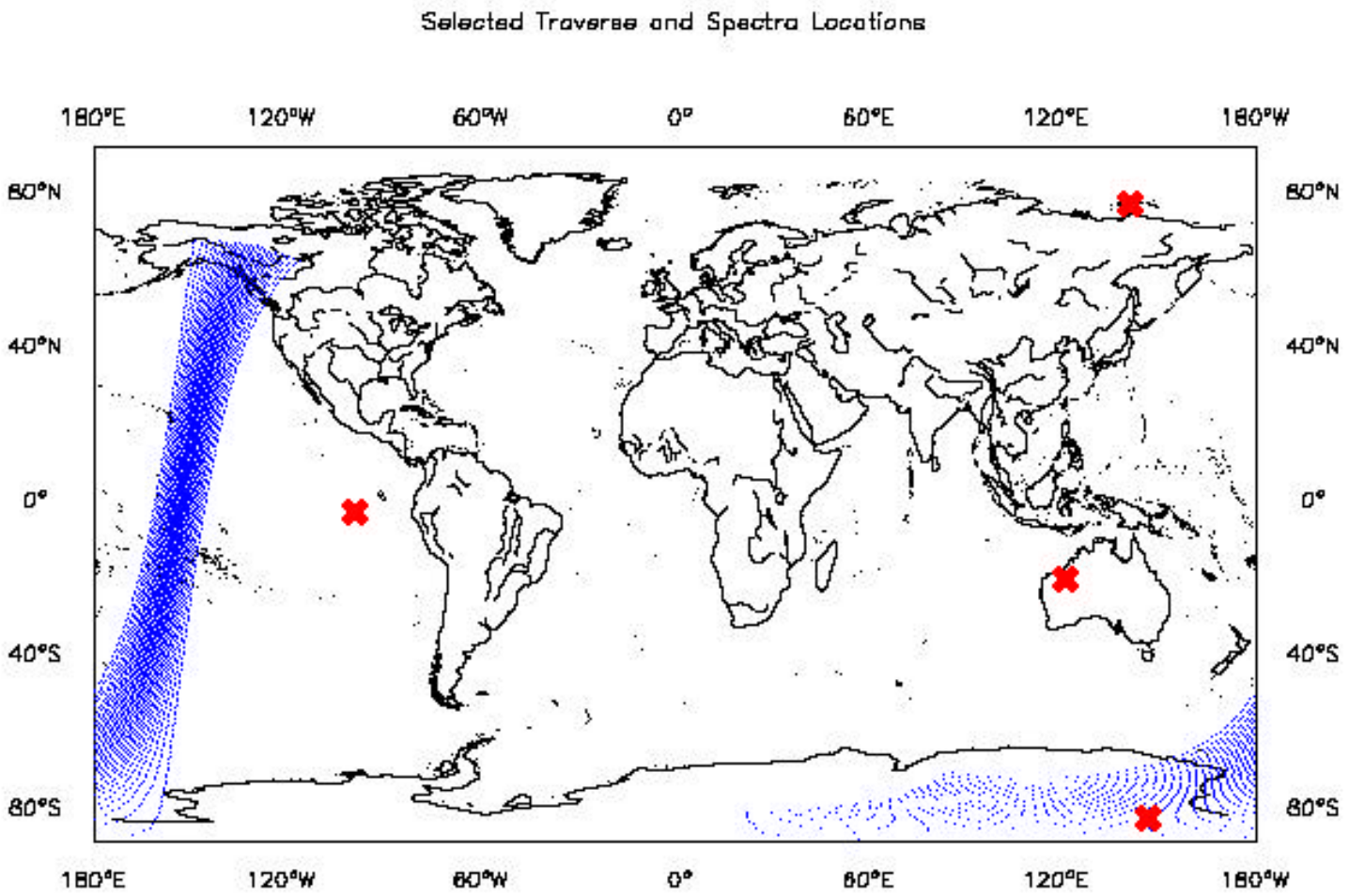


AMSU chan 6



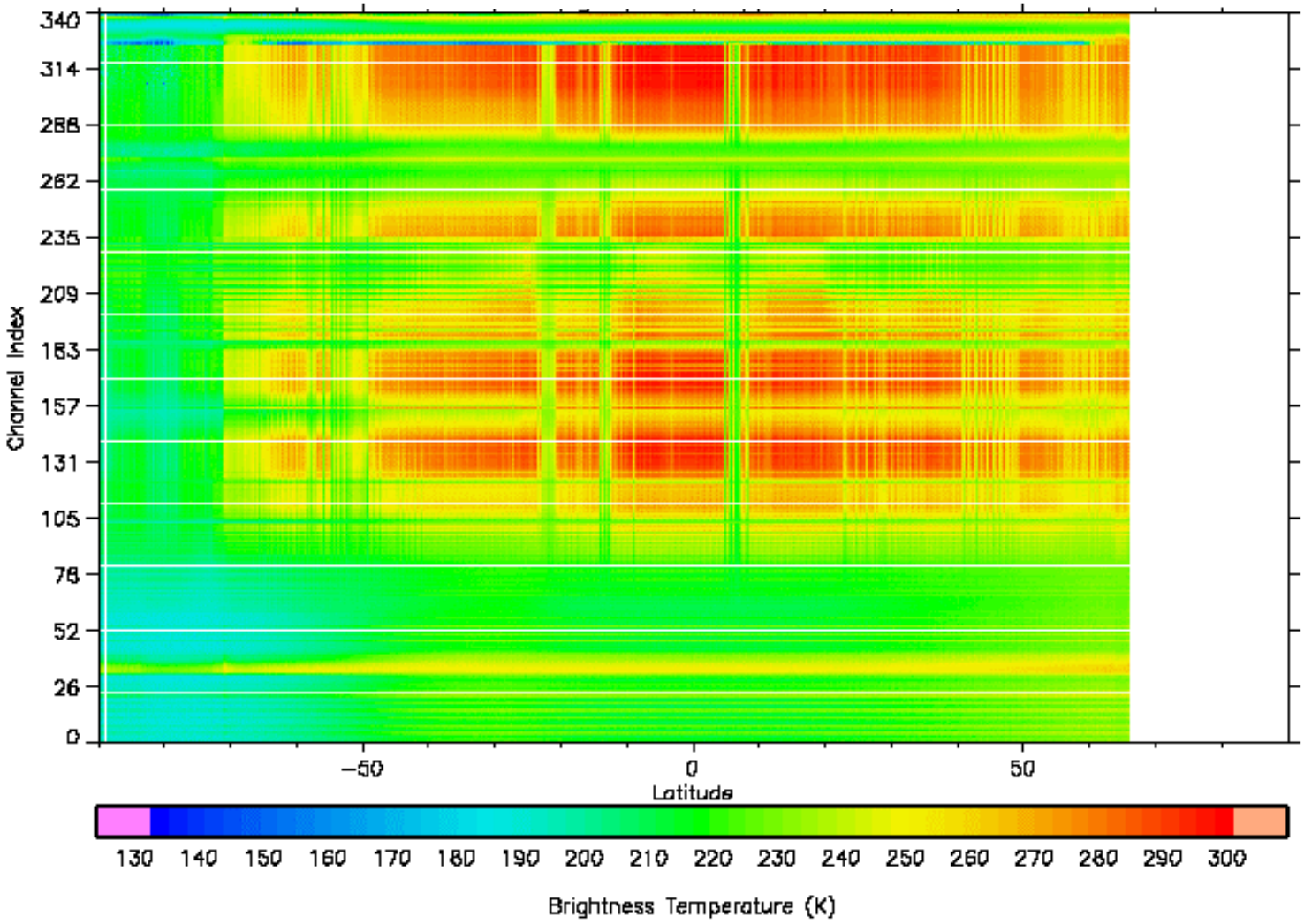
AMSU chan 7

Location of tartan/spectral plots



Tartan plots - BTs

Orbit over pacific



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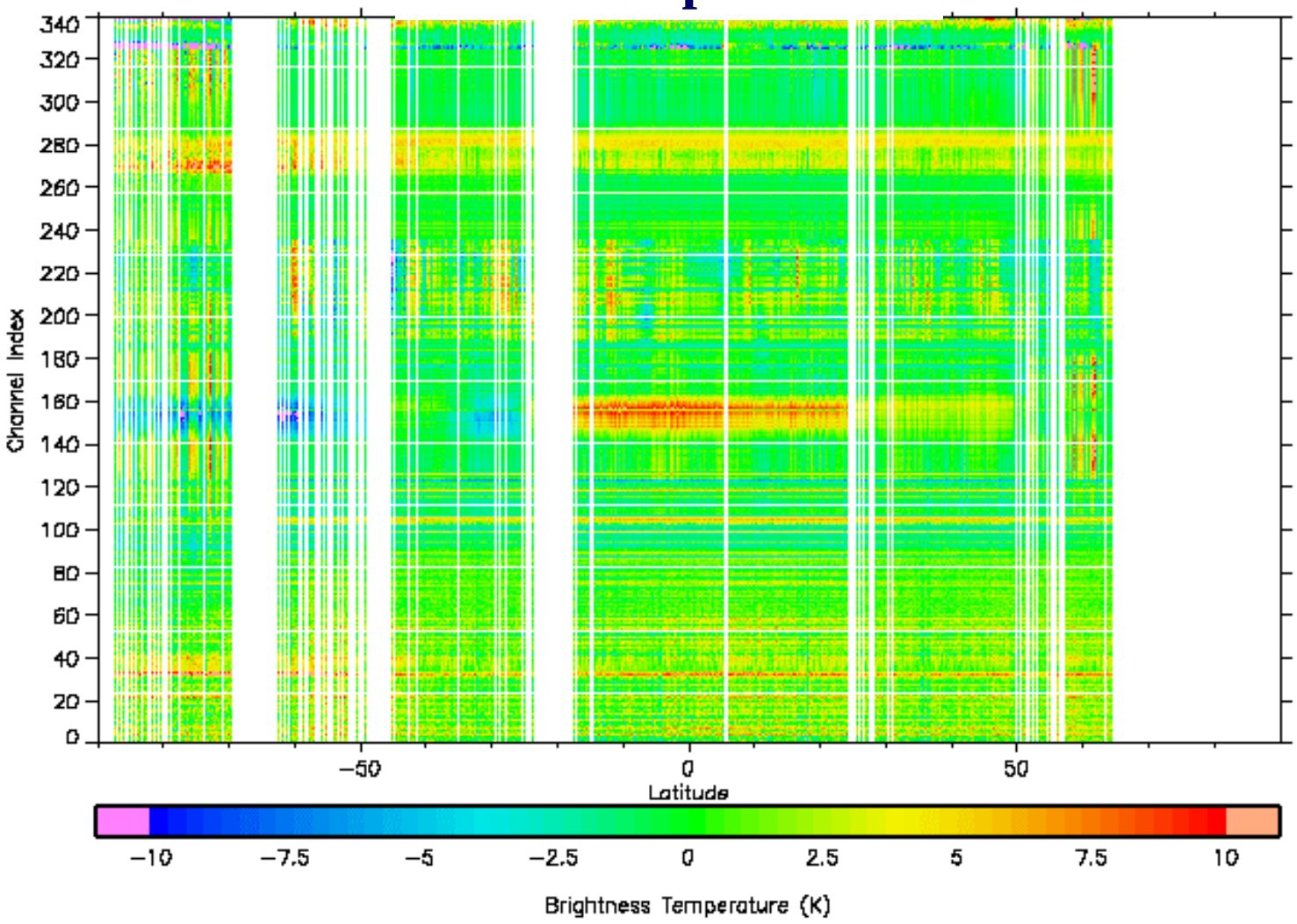
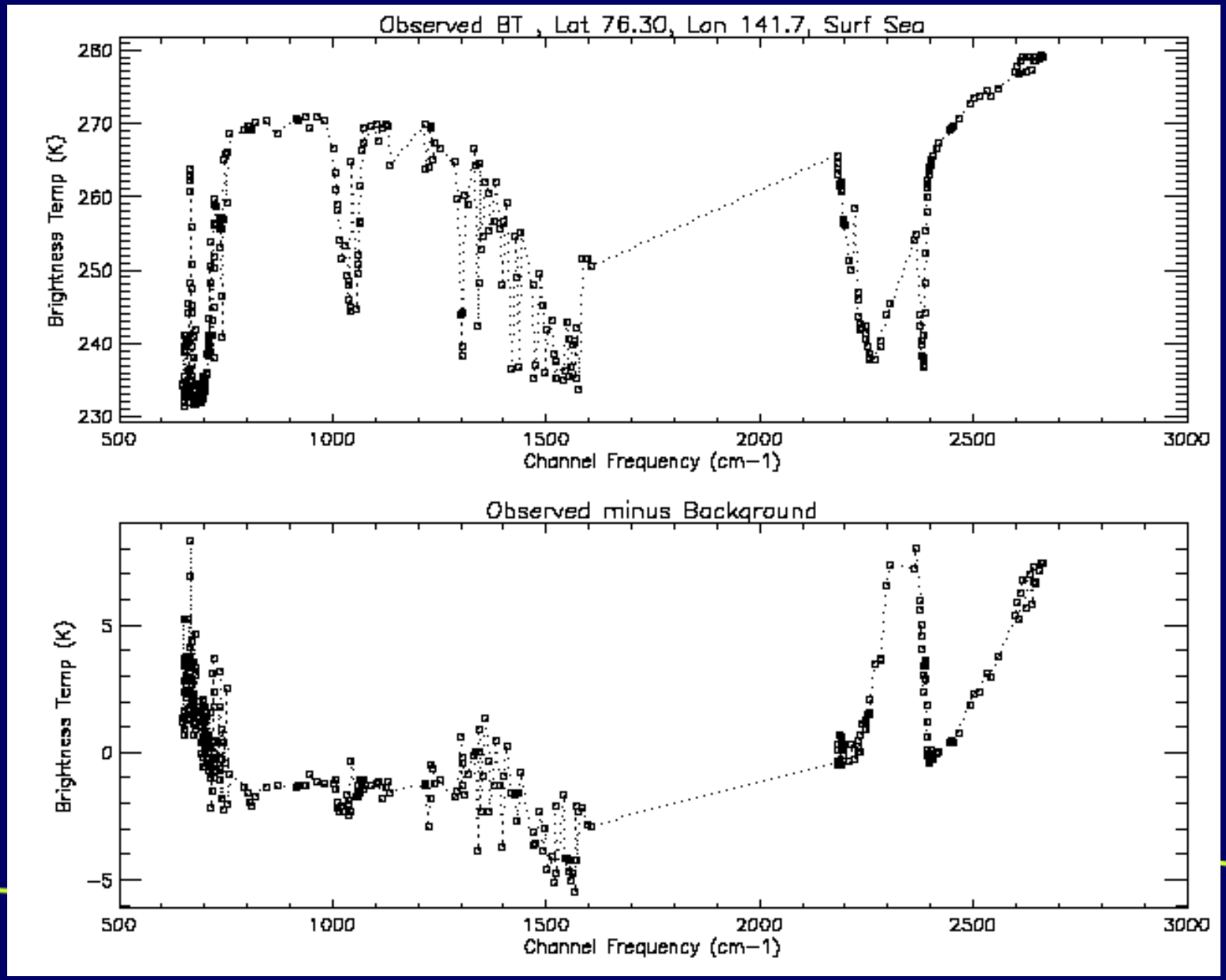
Tartan plots - O-B clear



Spectra over arctic ocean



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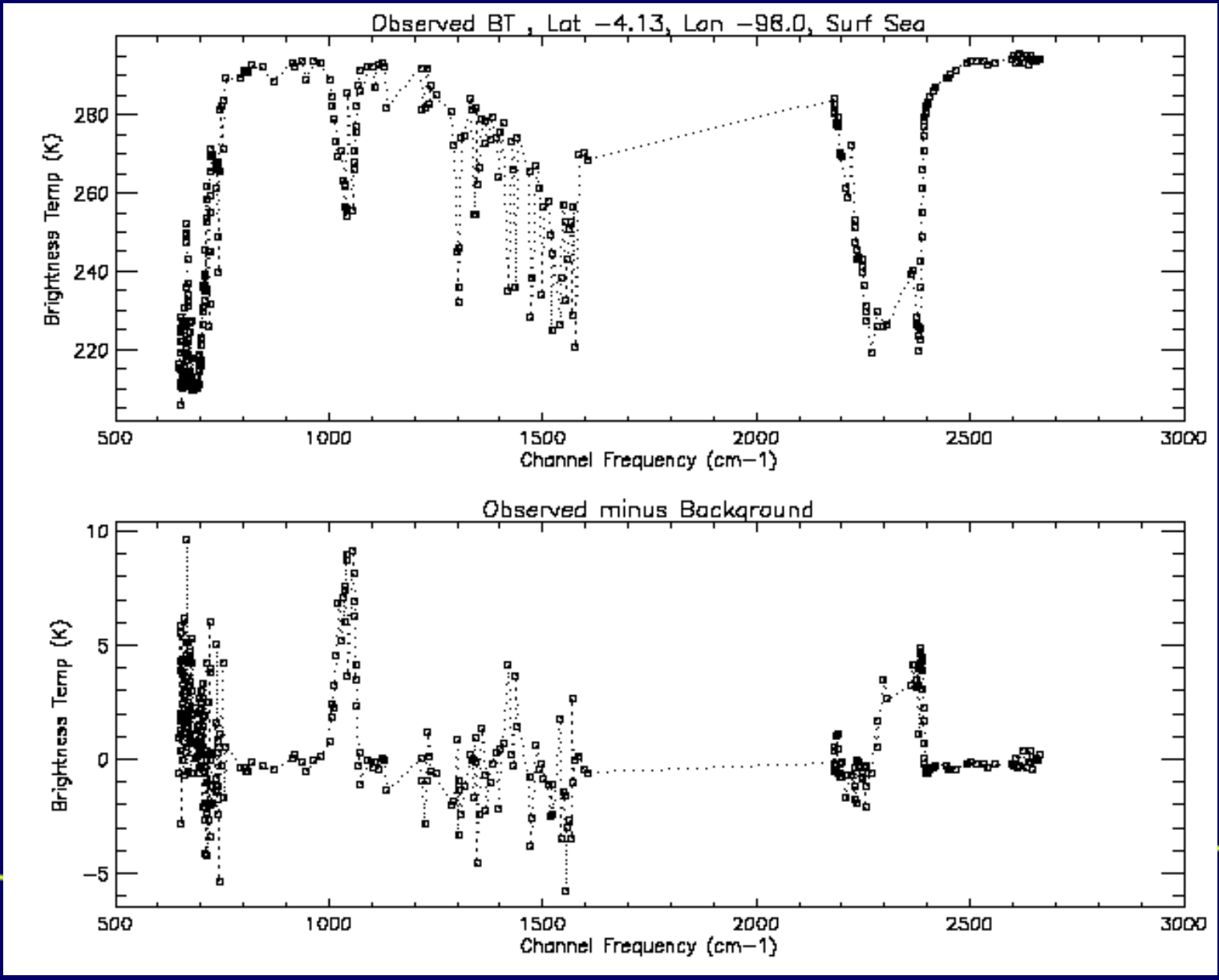
Spectra over tropical ocean



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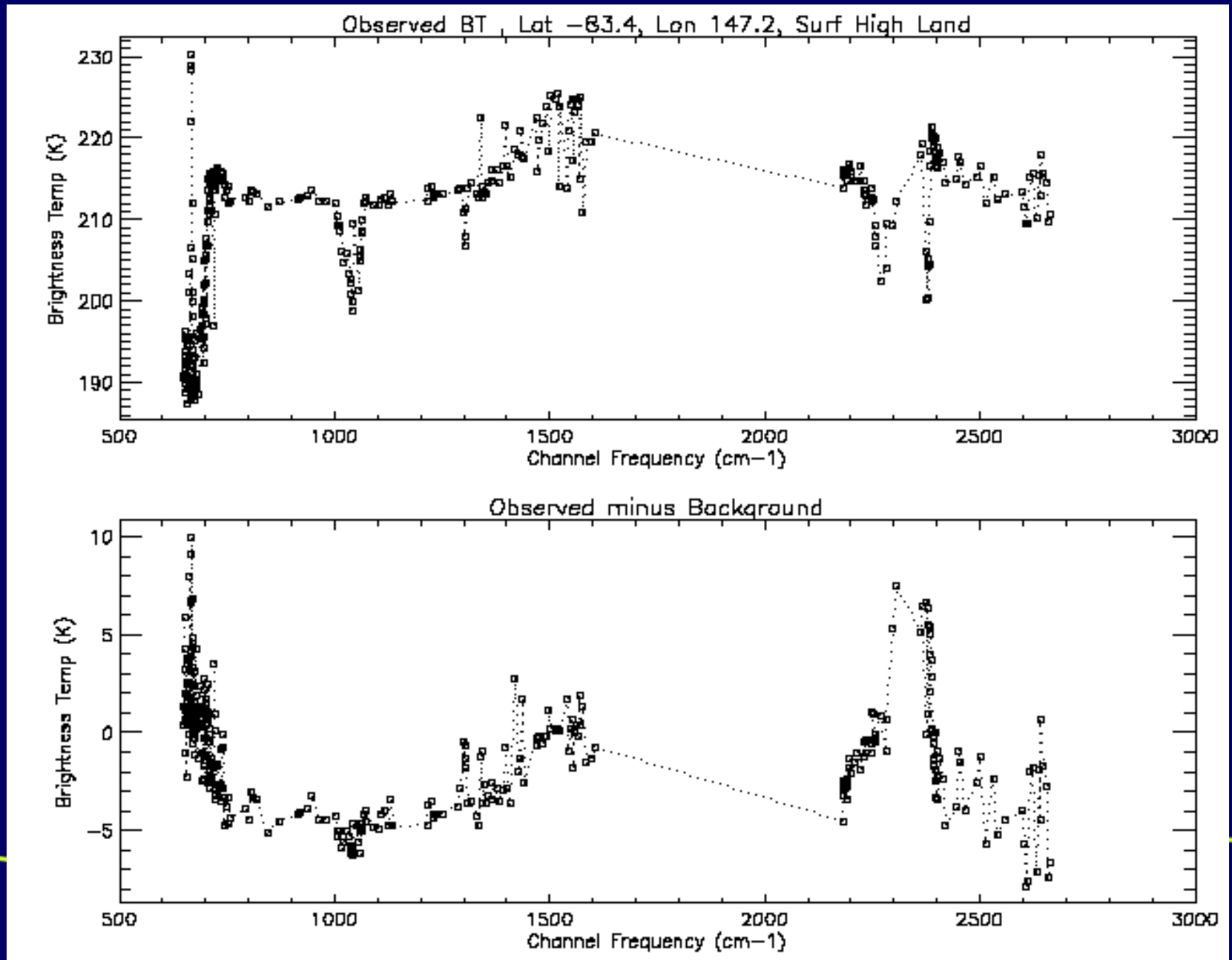
Spectra over Antarctica



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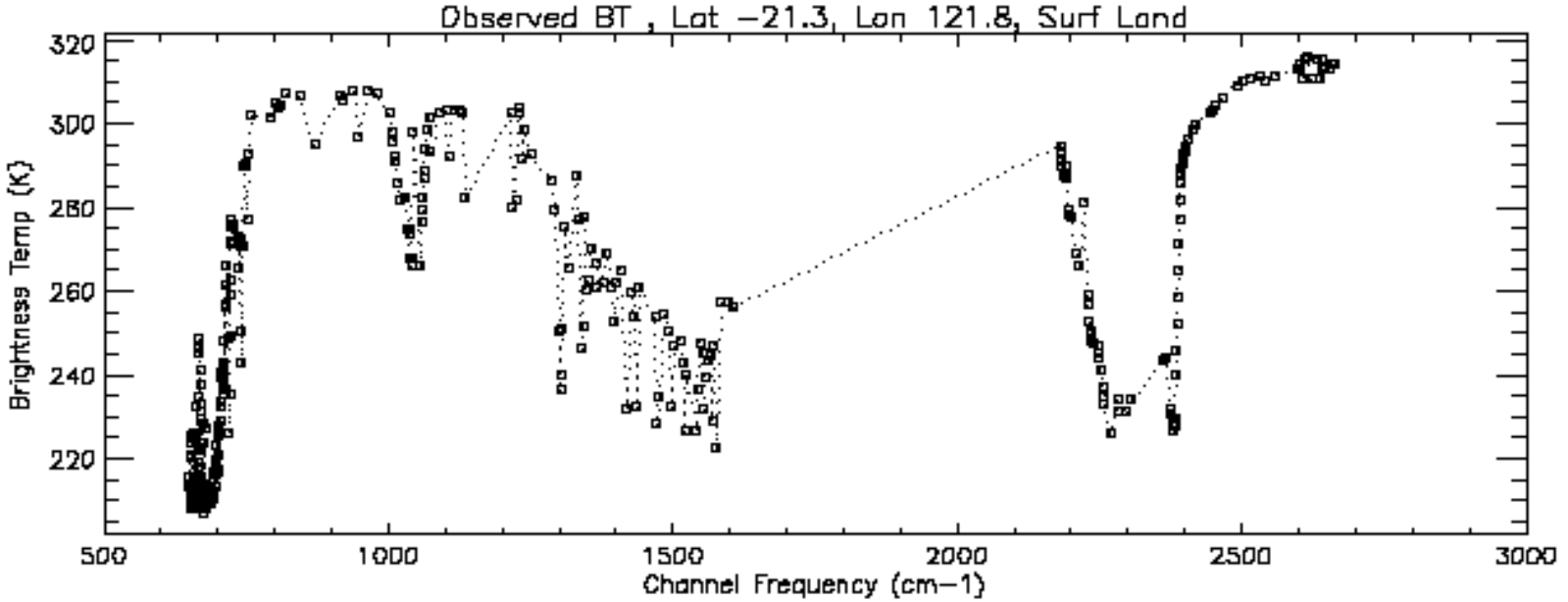
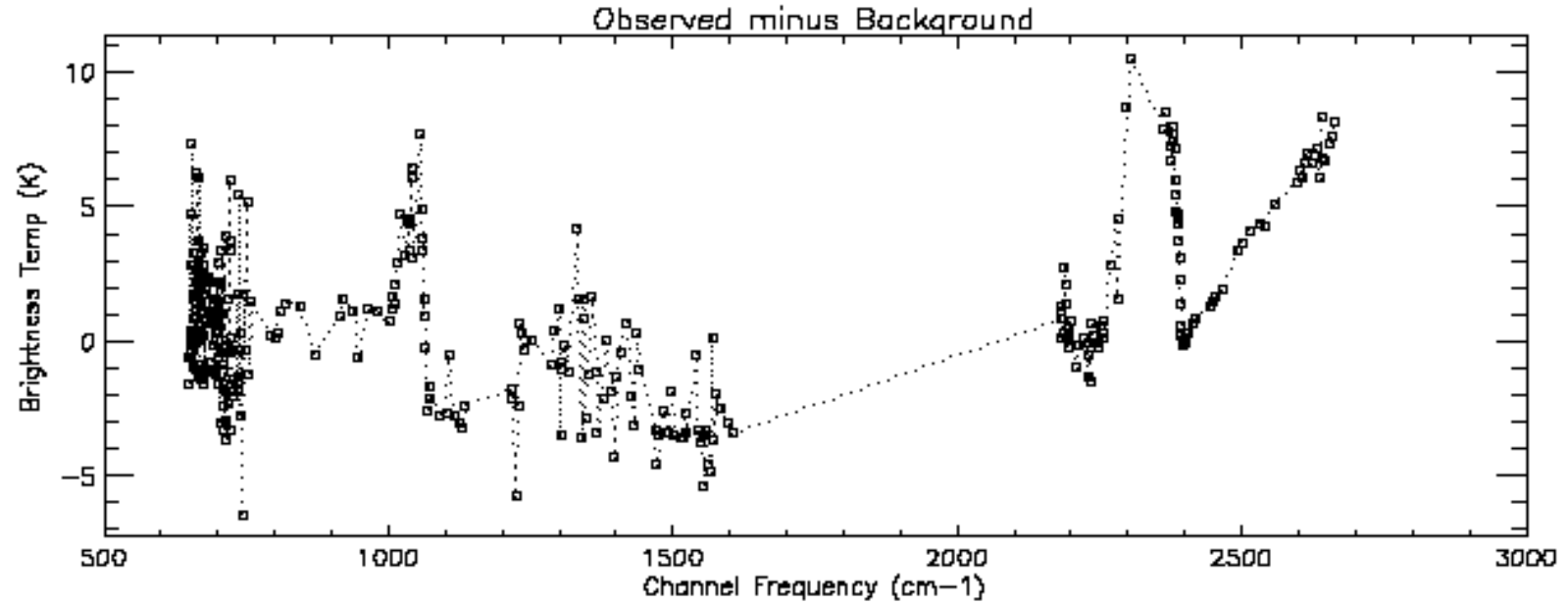
Spectra over Australian Desert





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Summary of results

- AIRS looks OK from first quick look
- More work needed on cloud detection
- Radiance bias correction has to be implemented
- AMSU channel 7 noisier than expected and some scan dep biases (like NOAA ?)
- HSB not yet monitored

Plans at Met Office

- Start continuous monitoring as soon as we are given access to data in real time (data partitioned into 6 hr intervals)
- Monitoring plots will be accessible via web site (see slide)
- Update RT model (see next slide)
- Once we have a ‘clean’ month of global data start NWP impact trial (early 03?)
- Report on NWP impact (mid 03?)

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Update RT model

Short term

- Recompute RTTOV-7 coeffs for new ISRF (in a few weeks)

Longer term

- Recompute transmittances on 101L with GENLN2 and/or kCARTA
- Use latest wv continuum *and model separately*
- Release RTTOV-8

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AIRS Monitoring Plots

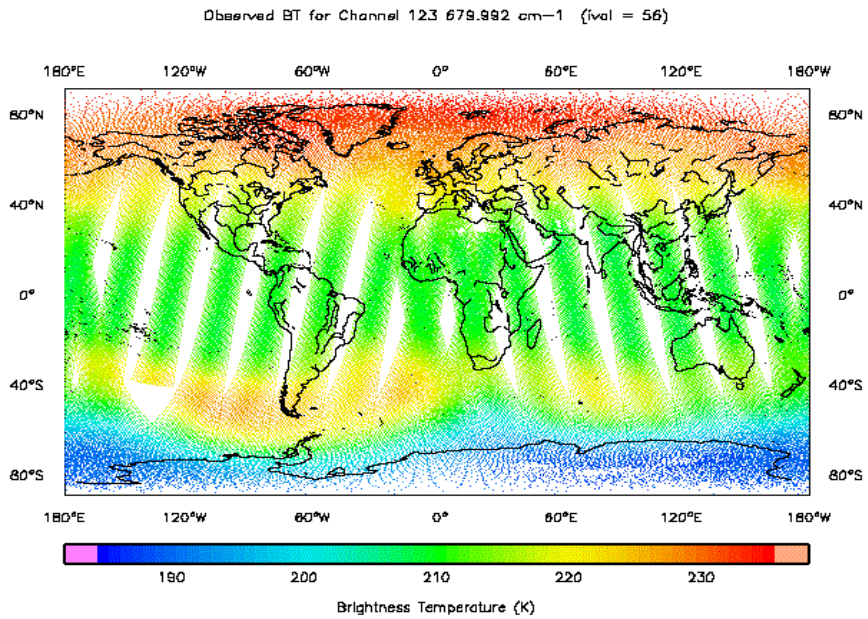
AIRS Monitoring Plots

These plots are considered experimental. The Met Office accepts no responsibility for actions taken on the basis of these monitoring plots.

Current: 57 First: 0 Last: 338

Plot Type: Map of Raw BT Skip to:

Map of Raw BT



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Draft monitoring web page

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AIRS impact assessment

- Radiance monitoring (are O-B stats reasonable?) compare with HIRS from NOAA-16
- Compare AIRS 1DVar retrievals with ATOVS and RAOB match-up profiles
- Look at analysis increments
  - Temperature and water vapour
- Look at forecast scores in range 1-5 days especially in S. Hemisphere *verified against Obs and Analyses*
- **What is control?**

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